

Edgar D. Lyman

THE APPARATUS
FOR
MEDICO-MECHANICAL GYMNASTICS
AND THEIR USE

BY

DR. GUSTAF ZANDER,
DIRECTOR OF THE MEDICO-MECHANICAL INSTITUTE OF STOCKHOLM.

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STOCKHOLM

P. A. NORSTEDT & SÖNER, PRINTERS TO THE KING
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Preface.

With this book I lay before the public the first complete description in English of all my apparatus hitherto constructed for pedagogic, orthopedic and medical gymnastics, with the hope that my mechanico-therapeutical method may meet with the same success in the English-speaking part of the world as it has in Germany where at present 31 more or less fully equipped, so called Zander Institutes have been established.

The practical minds of the English and the Americans will surely be attracted by a hygienic means which is able not only to overcome general and local states of debility, but also prevents them by the harmonious development and strengthening of the entire organism. It may be more convenient, and is considered as a less waste of time to cure diseases by taking medicine than by taking one hour's exercise daily. But the increased well-being and capacity for work which are the never failing result of these mechanico-gymnastic exercises are a very rich compensation for the time bestowed on them. For a man of business, that »health is money» may be as great a truth as that »time is money.»

Göransson's Mekaniska Verkstad Company Limited to whose director, Mr. E. F. GÖRANSSON C. E., I owe the technical and industrial development of my invention, has the exclusive right of manufacturing my gymnastic apparatus under my control. He is willing

to give all the advice and all the technical and economical information necessary for the establishment of medico-mechanical Institutes abroad, and has undertaken all the correspondence requisite for this purpose. Those of my honoured colleagues who may be inclined to establish such Institutes are advised to study, practically, my method of treatment for some time (at least for a month) preferably at my Institute in Stockholm, — especially if the purposed Institute is intended to comprise treatment of curvatures of the spine, — but also at some of the greater Institutes in Germany with complete equipment of apparatus. My Institute in Stockholm is open only from Sept. 21st till May 15th.

As the description of the use of the apparatus will scarcely be fully comprehended without a practical knowledge of their application, this book has not been provided with illustrations.

Stockholm, September 1894.

G. Zander.

Experience has shown that regular muscular exercises with progressive exertion do not only develop and strengthen the muscles, but also remove morbid changes in the tissues, strengthen the nervous system and accelerate the circulation of the blood and lymph as well as the functions of many organs, and therefore it was self-evident that these exercises should be introduced among the auxiliaries of medical science. For that purpose it was necessary, however, that they should be based on physiological laws and that their effects, like those of other remedies, should allow of modifications suited to each individual case.

From the year 1857 when I began to give my attention to medical gymnastics, I have been trying to meet these requirements by my mechanical gymnastic method, and I have shown in several publications that they could only be met, if the resistance to be overcome by the work of the muscles, is produced by means of mechanical apparatus and levers.

The object of the use of levers is: 1:o that the resistance will be in the strictest accordance with the physiological and mechanical laws for the action of the muscles; and 2:o. that the application of the remedy can be measured out in the most perfect manner.

I am not ignorant of the fact that at a comparatively recent date, and possibly also before my time, several persons have constructed single apparatus for medical gymnastics. Still, hitherto, no one but myself

has constructed a complete series of apparatus for the harmonious development of the whole muscular system, or indicated the principles according to which the lever should be used in each separate apparatus.

Therefore, if there exist to-day a *method of mechanical gymnastics*, it is mine.

As already stated, the mechanical gymnastic method makes use of mechanical apparatus, that is to say of a special one for the exercise of each separate group of muscles. The resistance to be overcome by each group of muscles is thus produced, that the alternate contraction and relaxation of the muscles causes a weight attached to a lever to be alternately raised and lowered. By means of the lever the important requirement is met that, *in the course of the movement the resistance increases and diminishes with the natural changes in the mechanical effect of the muscular action*. When this effect is greatest, the lever assumes the position in which it reaches its greatest momentum *i. e.* the horizontal; when the effect diminishes, the lever moves from this position; and when again the effect increases, the lever once more approaches the horizontal.

The weight can be moved along the lever and can be fastened, by means of a screw, at a greater or smaller distance from the fulcrum, so that any degree of resistance desired from zero to the maximum appropriate to each apparatus can be easily obtained.

Furnished with such apparatus, the mechanical gymnastic method offers the following advantages:

1. During the movement the resistance adapts itself exactly to the natural changes in the effect of muscular power.

2. The intensity of the movement is weighed, as in a balance and its exact degree can be measured.

3. The gradual increase of strength in the movement, so necessary for muscular development, can be made accurately and to any degree desired.

4. The resistance indicated by a given figure is always the same, and, therefore, any necessary regulation of the strength of the movement, whether increase or decrease, can be made easily and with precision.

In addition to the muscular exercises which are the essence of all gymnastics, my gymnastic method also makes use of passive movements for the articulations, such as arm-circumduction, foot-circumduction, and of mechanical operations: vibration, percussion, kneading &c, &c.

The Establishments where my medico-mechanical gymnastics are practised, are now generally called *Medico-mechanical Zander-Institutes*. The first was founded by me in Stockholm in 1865. From the year of the opening of this Institute, the gymnastic establishments of Sweden began to employ my apparatus, and since 1875 several Institutes of the kind have also been founded abroad. There are at present fully equipped Medico-mechanical Zander-Institutes in the following towns:

Stockholm (2 Institutes), Gothenburg, Christiania, Helsingfors, St Petersburg, Baden-Baden (2 Institutes), Hamburg, Berlin, Breslau, Mannheim, Frankfurt-on-the-Main, Dresden, Würzburg, Leipzig, Wildbad, Stuttgart, Wiesbaden, Aix-la-Chapelle, Ragaz, Karlsbad,¹ London, Buenos-Ayres, New-York, St. Louis.

There are Institutes with a partial equipment of apparatus at:

Stockholm (2 Institutes), Upsala, Örebro, Norrköping, Hjulsta, Åbo, Moscow, Copenhagen, Karlsruhe, Pforzheim. Nieder-Schönhausen near Berlin, München, Elberfeld, Bochum, Königshütte, Chemnitz, Essen, Neu-

¹ In course of foundation.

Rahnsdorf near Berlin, Wiesbaden, Hannover, Aue i Erzgeb., Halle (Saale), Nauheim, Duisburg, Neubrandenburg,¹ Brunswick,¹ Cologne,¹ Groningen, Vienna, Budapest, Vöslau-Gainfarn, Paris, Turin, Bologna, Baltimore, Batavia.

Single apparatus for private use have been sent to Riga, Erfurt, Barmen, Trier, Berchtesgaden, Meiningen, Nieder-Walluf a. Rh., Barcelona, Milan, Nicolajeff and Alexandria.

At present there exist in Stockholm two Institutes with complete equipment and two with a partial equipment of apparatus, of which latter Institutes one is established exclusively for treatment of lateral curvatures of the spine.

¹ In course of foundation.

The apparatus for mechanical gymnastic treatment are divided into the three following series, according as they are set in motion, or have to operate only by pressure (corrective pressure).

First series: Apparatus set in motion by the muscular power of the patient.

Second series: Apparatus set in motion by means of some motor (steam-, gas-, or electric-engine).

Third series: Apparatus exercising, by the weight of the patient's body, or by mechanical arrangements, a corrective pressure on the frame or producing the tension of elastic tissues.

According to their physiological effects, the apparatus are further divided into the following four sections:

I. **Apparatus for active movements** *i. e.* such as have for immediate object to exercise and develop the muscles. This section is divided into four groups:

- A. Active arm-movements.
- B. „ leg-movements.
- C. „ trunk-movements.
- D. Balancing movements.

II. **Apparatus for passive movements**, *i. e.* such as move the members of the body without the help of the muscles, stretching and softening capsules, tendons and muscles. This section contains only one group:

- E. Passive movements.

III. **Apparatus for mechanical operations.** This section contains four groups:

- F. Vibration.
- G. Percussion.
- H. Kneading.
- J. Friction.

IV. **Orthopædic apparatus** with the special object of being used in the treatment of curvatures of the spine. This section has two groups:

K. Passive redressments, which by suitably applied pressure on abnormal curvatures of the spine are intended to exercise a corrective influence.

L. Active redressments, in which certain active movements exercising corrective (self-straightening) influence on abnormal curvatures of the spine should be accomplished.

When these 11 groups are distributed on the three first mentioned series

1st series contains A. B. C. and L.

2nd series » D. E. F. G. H. and J.

3rd series » the group K.

The different apparatus belonging to each group are marked with the letter of the group as well as with a figure indicating the order. By the following table we obtain a summary of now (1894) existing apparatus for mechanical gymnastics. In some groups a few numbers are left out. They belong to apparatus, the construction of which is not yet completed, but which, I hope, will shortly occupy their place in the system.

I. Active movements.

A. Active movements of the arms.

- A 1 Arm-sinking.
- A 2 Arm-raising; shoulder-raising.
- A 3 Arm-drawing|downwards.
- A 4 Arm-stretching|upwards.
- A 5 Arm-adduction.
- A 6 Arm-abduction.
- A 7 Arm-circumduction.
- A 8a Arm-rotation (active).
- A 8b Arm-rotation (active-passive).
- A 9 Forearm-flexion.
- A 10 Forearm-extension.
- A 11 Hand-flexion and extension.
- A 12 Finger-flexion and extension.

B. Active movements of the legs.

- B 1 Hip-flexion.
- B 2 Hip-extension.
- B 3 Hip-knee-flexion; hip-raising.
- B 4 Hip-knee-extension; hip-sinking.
- B 5a Leg-adduction (sitting).
- B 5b Leg-adduction (half-reclining).
- B 6 Leg-abduction.
- B 7 Velocipede-motion.
- B 8 Leg-rotation.
- B 9 Knee-flexion.
- B 10 Knee-extension.
- B 11 Foot-flexion and extension.
- B 12 Foot-circumduction.

C. Active movements of the trunk.

- C 1 Trunk-flexion (sitting).
- C 2 Trunk-extension (sitting).
- C 3 Trunk-raising and flexion.

- C 4 Trunk-extension (long-sitting).
- C 5 Trunk-extension (standing).
- C 6 Trunk-sideways-flexion.
- C 7 Trunk-rotation.
- C 8 Pelvis-rotation.
- C 10 Neck-extension.

D. Balancing movements.

- D 1 Trunk-balancing.
- D 2 Pelvis-circumduction (transversal sitting).
- D 3 Pelvis-circumduction (saddle-sitting).

II. Passive movements.

E. Passive movements.

- E 2 Hand-flexion and extension (passive).
- E 3 Hand-adduction and abduction (passive).
- E 4 Finger-flexion and extension (passive).
- E 6 Chest-dilatation.
- E 7 Trunk-rotation (passive).
- E 8 Pelvis-elevation.

III. Mechanical operations.

F. Vibration.

- F 1 Vibration of different parts of the body.
- F 2 Vibration of the whole body (saddle-sitting).

G. Percussion.

- G 1 Trunk- and arm-percussion (I size).
- G 3 Leg-percussion.
- G 4 Trunk- and arm-percussion (II size).
- G 5 Head-percussion.

H. Kneading.

- H 1 Abdomen-kneading.

J. Friction.

- J 1 Arm-friction.
- J 2b Finger-friction.
- J 3 Leg-friction.
- J 4 Foot-friction.
- J 5 Back-friction.
- J 6 Circular abdomen-friction.

IV. Orthopædic apparatus.

K. Passive redressments.

- K 1 Lateral suspension (reclining).
- K 2 Lateral pressure (lying).
- K 3 Chest-rotation (lying).
- K 4 Straightening lumbar curvatures (sitting).
- K 5 Lateral pressure (sitting).

L. Active redressments.

- L 1 Combination of A3 and D1.
- L 2 Extension or lateral flexion of the lumbar spine.
- L 3 Carrying the pelvis sideways.
- L 4 Carrying the pelvis forwards-backwards.
- L 5 Lateral flexion of the lumbar spine.
- L 6 Straightening the spine.

Measuring apparatus.

Trunk-measuring.

Cross-cut-measuring.

Examining-chair for scoliosis.

General Rules for the use of the apparatus.

The movements which must be taken in the order indicated on the prescription, are divided into groups of three movements each. As a rule it is the first movement of the group which requires the greatest effort, *i. e.* an active arm- or trunk-movement. Then follows an active leg-movement and, at last, a passive movement or one of the mechanical operations. For more robust persons, however, more trying movements can be combined in the same group; in that case the third movement can be either a balancing movement or an active trunk-movement. The three movements of the same group are taken immediately after each other, and then the patient should rest about 5 minutes, unless rest be prescribed after each movement.

In the beginning, all the movements should be slight. Even should the patient consider them insufficient, their strength should not be increased during the first days. In fact, even if each separate movement seems too slight in proportion to what he believes himself able to support, all the movements together require a considerable degree of activity, not only of the muscles, but also of the nerves, and greater fatigue than was expected, is felt, especially towards evening. Gymnastic movements have an infinitely greater effect than the ordinary, chiefly automatic movements of daily life.

The degree of force that the physician deems suitable for the patient, is, for part of the movements,

approximately indicated on the prescription. But the instructor, who has supervision while the movements are taken, is free to diminish the strength if they are too strong, but he should take care not to increase it too soon. The first day or days all the groups should not be attempted, at least not with delicate persons.

After a few days when the first weariness has passed away, or if none has been felt, the intensity of the movements may be increased one degree at a time, until some slight fatigue is noticed. Then this degree of effort is maintained, until the weariness is entirely overcome, when the resistance is further increased. If these precautions are taken, the strength of the patient increases slowly but surely.

From what has been said, it is obvious that all fatigue is not to be anxiously avoided. Exertion, up to a certain degree, is an indispensable condition for increase of strength. As, however, a large number of persons using medical gymnastics are obliged during the period of treatment, to go on with their ordinary occupations, which alone cause weariness, the strength of such patients should be carefully economised, if they are to make progress. Hence the strict rule, not to use greater intensity of movement than to cause but a slight and quickly passing weariness.

There is no doubt, that with patients who are able to give themselves up entirely to the gymnastic treatment, and to undergo it two or three times daily with sufficient interval of rest, more speedy and more complete results are obtained than is generally the case in medical gymnastic Institutes.

There are patients whose weariness is persistent, even though they have only a few slight movements. That is, however, no reason for losing courage. In some particular cases, the fatigue has lasted weeks and even months, before it has gradually passed away,

giving place to an amazingly rapid increase of strength and general health. This form of weariness is a nervous affection due to various weakening influences, but principally to an enervating mode of life and a careful avoidance of all physical exertion, dancing and late hours perhaps excepted. Absolute rest, if such were possible, might improve this state, but medical gymnastics alone can restore health and strength to such patients. In that case they should of course submit themselves exclusively to gymnastic treatment. Unfortunately the persistent weariness often induces them to abandon the treatment too soon.

The prescription is methodically composed according to the needs and condition of the patient. Therefore no change in the sequence of the movements should be made without consulting the physician. Those who use gymnastics without suffering from any particular disease, and merely for the purpose of maintaining health and strength, should keep to the order prescribed within each group, but may alter the sequence of the groups. To gain time, movements of one group may be exchanged for similar ones of another group, as for instance, arm-, leg- and trunk-movements.

Any arbitrary modification of the movements in the prescription would, on the contrary, be out of the question, and certainly not tolerated.

The treatment intended to strengthen the constitution in general, by exercising and developing all the muscles, forms, as it were, the basis of the prescription. This treatment is afterwards modified and developed in such a way that the movements calculated to affect some special ailment or disease become predominant by their repetition. Insight and experience are required for making and carrying out such a plan of treatment, besides a careful consideration of such modifications as occasional circumstances may render necessary. That is exactly what many people do not seem to

understand. They omit movements which are not agreeable to them, or of which they do not see the use, and take others not prescribed but which they prefer, and which seem to them more suitable, perhaps because they bring into activity stronger and more exercised muscles. It is natural that these movements should seem agreeable and beneficial, while work with feeble and unexercised muscles is tiring and disagreeable. However — the more the strong muscles are exercised at the expense of the weak ones, the more the organism degenerates, becomes unfit for its natural functions, and loses its power of resistance against unhealthy influences. The object of gymnastics is not attained, and the patient ascribes the failure to the method instead of attributing it to his own unreasonable self-will.

A deep and regular respiration is of the greatest importance during the movements. The rhythm of the movement should coincide with the normal rhythm of the respiration, — that which most easily allows the production of deep inspirations and expirations. Each active movement has two successive phases, one requiring greater effort (when the muscles contract and the lever of the apparatus is raised) and the other less effort (when the muscles relax and the lever is lowered), and, when taking a movement one is inclined to make the inspiration coincide with the phase requiring greater effort and the expiration with that requiring less.

It is, however, necessary to do the reverse with certain movements, *viz.* those in which the expiratory muscles take part, such as A1, A3, C1, C3, C7, C8, L1, L3 and L5. In all of them you make first a deep inspiration and begin the movement with the expiration. As to C6, see the special description of this movement.

There are some other movements in which the only instruction necessary is to respire deeply and

calmly, *viz.* A7, A8b, B7, B11, B12, the balancing and passive movements as well as the mechanical operations.

Further rules to be observed:

Patients should reach the Institute in time to take the prescribed movements quietly and with sufficient intervals of rest.

They should not fatigue themselves before or after gymnastic exercises, which rule must be particularly observed by patients suffering from heart-disease or from general weakness.

The physician should be informed if, nevertheless, marked or continued weariness follows the exercise.

The whole attention should be given to the exercise, and there should be neither conversation nor reading while it lasts.

Those who take gymnastics for general weakness should avoid dancing and late hours.

Loose comfortable clothing should be worn, leaving waist and throat free, the breathing and the use of the arms unimpeded and the abdominal organs without pressure. Stays, tight neck-ties and garters should be avoided.

A substantial meal should never be taken immediately before beginning gymnastics. A cup of coffee, tea or milk with a roll is harmless, and in some cases necessary, for elderly and delicate persons. After a hearty breakfast one or two hours should pass before beginning gymnastic exercises.

The application and effect of each separate apparatus.

A. Active movements of the arms.

A 1.

Arm-sinking.

The upward stretched arm is moved outward and downward until it hangs straight down. The movement is made first with one arm, then with the other.

The seat on which the patient is placed can be pushed to the right or left on tracks along the apparatus, and the angular shoulder-support can be turned accordingly. If the movement is made with the right arm, the seat is pushed to the left (seen from the apparatus) and the side-support turned to the right; and *vice versa* when the movement is to be made with the left arm.

After the patient has placed himself sideways against the shoulder-support, the seat is screwed higher or lower, so that the shoulder-joint comes on a level with the shaft of the apparatus. The hand grasps the movable handle, while the arm is stretched upwards along the vertical lever.

First, deep inspiration; during the following *expiration* the arm is moved downward until it hangs vertically; during *inspiration*, while slowly yielding to

the pressure of the lever, without moving away from the shoulder-support, the arm is carried back to the upright position.

Effect: on the strong dorsal and thorax muscles. The extensors on the back of the upper arm contract in order to keep the arm stretched. The lateral flexors of the trunk contract on the side that makes the movement and prevent the trunk from bending over to the opposite side. The movement causes the development of the thorax, and if the shoulder is fixed by a strap or by the hand, is of great use in removing stiffness of the shoulder-joint and its muscles.

On the humerus act: the *pectoralis major*, *latissimus dorsi*, *teres major*, dorsal third of *deltoideus* (to 45° below the horizontal) and the *anconæus longus*.

On the shoulder-blade act: the *rhomboidei*, the *levator anguli scapulæ* and the *pectoralis minor*.

A 2.

Arm-raising; Shoulder-raising.

The arms are to be stretched upwards; the shoulders to be raised and to make a circumductory movement.

The apparatus consists of 10 pair of dumb-bells of from 0,5 to 5 kilogr. in weight.

Arm-raising is made from two different starting-positions.

No 1. The patient takes one dumb-bell in each hand, standing erect, heels together, arms hanging down. During *inspiration* the arms — always stretched — are moved forward and upward; during *expiration*, backward and downward to the starting-position. The inspiration should begin when the arms are half-way forward and upward, and the expiration not until they are moved a little backward.

N:o 2. The same starting-position as before, with the difference only that the arms are *sharply bent at the elbow-joint*, so that the forearm rests against the upper arm which hangs straight down and the hands are on a level with the shoulders. During *inspiration* the arms are stretched straight upwards, during *expiration* they are brought back to the starting-position.

Shoulder-raising. Starting-position as above in N:o 1. During *inspiration* the shoulders are moved forward and upward, then backward and downward into the starting-position, while the arms, charged with the weights, must remain stretched and hanging down. During *expiration* the shoulders are kept still and the movement recommences with the *inspiration*.

In scoliosis this movement is made unilaterally.

Effect: partly on the deltoid muscle which covers the shoulder-joint, partly on the muscles extending from the neck and spine, as well as from the lateral surface of the thorax to the shoulder-blade, partly also on the muscles of the back of the upper arm. Being a vigorous inspiratory movement, it promotes the development of the thorax.

The arm is raised to the horizontal position by the *deltoideus* and *supraspinatus*, while the *serratus anticus major* fixes the shoulder-blade and the *claviculo-acromial* portion of the *trapezius* raises the outer end of *clavicula*. The dorsal third of the *deltoideus* raises the arm only to 45° from below outward. The arm is raised from the horizontal to the vertical position by the *serratus anticus major* and the lower part of the *trapezius*, which turn the shoulder-blade outwards in the *acromio clavicular* joint. While the arms are still stretched forward the long dorsal muscles also contract. The *anconæus internus*, *externus* and *brevis* hold the arm stretched, or stretch it while it is being raised. By the second starting-position the *biceps* and *brachialis* are also brought into activity. In shoulder-raising the shoulders are drawn up by the *trapezius* (upper half) and moved forward and upward by the *pectoralis major* (superior part) and backward by the *latissimus dorsi* (superior part).

A 3.

Arm-drawing downwards.

(Arm-sinking and flexion.)

The upward stretched arms are to be lowered, and bent at the elbow-joint. (Reverse of A2, second starting-position.)

The patient places himself under the pendent handles. Before the exercise begins, the cords, from which the handles are suspended, should be so adjusted that in order to grasp them, the patient must hold his arms strongly bent at the elbow-joint, the upper arm vertical and his hands on a level with his shoulders. (Compare A2, starting-position N:o 2).

The levers of the apparatus are fastened in an horizontal position by means of a checking mechanism, which can be fastened and undone by the foot.

After the handles are adjusted as described above and the patient has grasped them, he pulls the cords a little so as to undo this mechanism, and then lets the levers draw his arms upwards. This is the starting-position of the movement. The patient then alters his position so that his arms are stretched straight upwards and not inclined forwards. The head is held high, the chest expanded. *First a deep breath is drawn.* During *expiration* the arms are moved downwards, till the hands are on a level with the shoulders; the elbows must be closely drawn back. During *inspiration* the arms are again moved upwards.

Effect: on the strong back- and thorax-muscles which pull down the upward stretched upper arm; the flexion of the elbow-joint is more passive and acts but little on the flexors of this joint. The movement promotes the development of the thorax.

On the humerus act: the *pectoralis major* and *latissimus dorsi*, the *teres major*, the dorsal third of the *deltoideus* (to 45° below the horizontal) and the *anconæus longus*. *On the scapula:* the *rhomboidci*, the *levator anguli scapulæ* and the *pectoralis minor*.

By means of the costal-insertion of the *pectoralis* and the *latissimus dorsi* the movement works so that the breast-bone and ribs are drawn upwards, whereby the thorax also in expiration to a certain extent retains the position of inspiration. The movement, therefore, affects a sunken and inelastic thorax by expanding it and diminishing its resistance to the activity of the inspiratory muscles.

A 4.

Arm-stretching upwards.

The arms, held in acute-angular flexion are to be raised upwards, so that, at the same time, the forearm is stretched and the upper arm raised. The movement is the reverse of A3 and corresponds to A2, second starting-position; only, in the latter the patient stands free and uses loose weights (dumb-bells) as resistance, while in A4 this works on the lever. The apparatus is furnished with two parallel levers, of which the upper one holds the handle and can be raised or lowered according to the shoulder-height of the patient. The patient places himself with his toes against the board fastened on the floor, and takes hold of the handle-bar with the arms sharply bent so that the backs of the hands touch the shoulders. The whole body which is to be held erect, with expanded chest, is somewhat inclined forward and this position is to be maintained throughout the whole movement. During *inspiration* the arms are stretched upwards; during *expiration* they are moved back until the hands are on a level with the shoulders. The patient must take care to keep the inclined position.

Effect: on the deltoid muscles which cover the shoulders, on several large muscles extending from the

thorax and spinal column to the shoulder-blade, as well as on the extensors of the upper arm. In consequence of the forward inclined position the abdominal muscles contract and fix the lower ribs, while, by the stretching upwards of the arms, the thorax-muscles elevate the upper ribs, thereby expanding the chest. This is therefore a powerful inspiratory movement which promotes the development of the thorax.

As to the muscles acting see A2.

A 5.

Arm-adduction (horizontal).

The arms, stretched horizontally sideways, are to be drawn together in front. (Adduction of the arms.) The seat is screwed so high that the arms of the patient rest comfortably on the lever-arms of the apparatus the supports of which are screwed close enough together to touch the patient's sides without pressing them. The back-support is pushed back far enough for the shoulder-joints to be placed just above the vertical shafts on either side. The hands with their backs somewhat reversed, loosely hold the outer side of the lever-arms.

During *inspiration* the arms are drawn together until the lever-arms touch each other; during the following *expiration* they are slowly moved back somewhat behind the connecting-line of the shoulders.

Effect: on the anterior muscles of the thorax (the *pectoralis major*) and of the shoulder-joint (anterior third of the deltoid). The movement strongly promotes the development of the thorax.

As the patient's arms rest on the supports and the *deltoideus* therefore is not required to act in order to hold them in the horizontal position, the entire *pectoralis major* can work, even its inferior third, which otherwise would counteract the *deltoideus*. It is, however, exactly this inferior part of

the *pectoralis* which can exercise an expanding influence on the thorax by raising the sternum and the middle ribs and with them all the others, and this all the more that, in the case of this movement, the insertion of the muscles is at the same height as the shoulder-joint. Throughout the movement, as well during its less active phase (the drawing backward) as during the more active (the drawing forward) there works on the front of the thorax a drawing upward, backward and outward, *i. e.* a more or less decided inspiratory position is attained. Although the movement does not act so strongly as the downward-drawing-movements A1, A3, it is very effective, and this should be emphasized the more, as the charge has been made against it, that it justifies an apprehension of compression of the thorax.

A 6.

Arm-abduction (horizontal).

The arms are to be horizontally drawn backwards. (Abduction of the arms.)

The apparatus is adjusted in the same way as is prescribed in A5. The hands, of which the backs are turned inwards against each other, loosely hold the inner side of the lever-arms. The patient sits only far enough on the seat for his back to lean slightly against the back-support.

During *inspiration* the arms are moved outwards and backwards, a little behind the connecting-line of the shoulders; during *expiration* they are slowly moved forward.

Effect: on the muscles of the back and of the posterior side of the shoulder-joint. The dorsal muscles have to hold the back against the back-support.

Muscles called into action: the *deltoideus* (posterior third), the *latissimus dorsi*. The shoulder-blade is fixed and somewhat moved backward by the *trapezius* and the *rhomboidei*.

A 7.

Arm-circumduction.

The arm describes a circle round an imaginary axis passing horizontally outward through the shoulder-joint. Every point on the arm describes a circle which becomes wider the nearer it is to the peripheral end of the limb.

Such a movement is executed when the patient places his arm on the swinging bar of the apparatus and sets it in motion. The patient sits sideways against the crutch meant to receive the shoulder and stretches his arm along the swinging bar while holding it loosely with his hand. The seat is screwed up or down so as to fit the armpit in the crutch.

The figure on the prescription refers to the movable socket on the graduated lever. The counter-balance at the other end of the lever must also be moved to the corresponding figure on the scale so as to establish a perfect balance. The circumduction of the arm is brought about and carried on by slight muscular effort of the patient who moves the swinging bar in a circle first to one side and then to the other, each movement for about half a minute. The movement is made in the same way with both arms unless other prescriptions should be given.

The breathing must be deep and slow, so that two turns go to each inspiration and two or three to each expiration. The capsule of the shoulder-joint as well as several arm-, thorax- and back-muscles are alternately stretched and relaxed by this movement.

The movement is effected by the *depressors* of the arm. the *pectoralis major*, *latissimus dorsi*, as well as by the *teres major* and the *rhomboidei*.

A 8 a.

Arm-rotation (active).

By means of this apparatus the rotation of the arm forward and backward (pronation and supination) is specially practised.

The seat is raised so that, placed upon it, the patient holds his arm horizontally when he grasps the handle. The arm is kept stretched.

In turning forward, the handle is placed horizontally by means of a spring-bolt; turning backward it is placed vertically. The movement is made alternately with both arms, the patient reversing his position when it is the turn of the second arm. The hand can describe $\frac{3}{4}$ of a circle. In pronation the movement begins with the back of the hand turned downwards and the thumb backwards; in supination the back of the hand is turned forwards, the thumb downwards.

As regards respiration this movement belongs to the first category (p. 17): inspiration, on raising the lever.

When the patient seems inclined to hold his arm bent, the resistance may possibly be too strong and must be diminished one or two degrees.

The movement acts chiefly on the muscles of the inner side of the forearm (pronators) and of the outer side (supinators), but also on some muscles of the upper arm and of the shoulder-joint; it causes an increased flow of blood towards the arms.

Pronators: the *pronator teres* and *quadratus*, *radialis intermus*, *brachio-radialis* (to the middle position), *subscapularis*, *teres major* and *latissimus dorsi*.

Supinators: the *supinator brevis*, *radialis externus longus* and *brevis*, *brachio-radialis* (to the middle position), *biceps brachii*, *infraspinatus* and the *teres-minor*.

A 8 b.

Arm-rotation (active-passive).

Turning the arm forwards and backwards with slight resistance from alternate sides.

The object of this apparatus is less to exercise the rotary muscles of the arm than to cause, by their tension as well as by that of the tendons and joint-capsules of the arm, partly their mollification, partly greater affluence of blood, thus attaining, without muscular effort, diversion of blood from head and thorax.

The seat is screwed so high that the patient placed on it with his arm extended, must hold the latter horizontally after grasping the handle. By turning the handle, a fly-wheel is set in more or less rapid motion by means of a gearing. The rotation of the wheel causes a more thorough rotation than the muscles alone could effect; it is checked by the resistance of tendons and ligaments. The wheel should not be made to rotate more rapidly than so that a moderate tension of the tendons causes it to come to a standstill. Not until this is done, does one begin to contract the reverse rotary muscles to set the wheel in motion in the other direction. If the tension is felt too strongly one needs only to let the handle go.

The breathing should be deep and calm.

Muscles in action: the same as in A 8 a.

A 9.

Forearm-flexion.

The forearms are to be bent in the elbow-joint.

The patient places himself on the seat which is so adjusted that the lower edge of the arm-support is

just above the elbow-joint; he should sit only far enough into the chair to let his upper arms hang vertically.

The handles are to be held loosely with flat hand, the hollow turned forwards so as to leave them some play.

During *inspiration* the arms are bent upwards as far as possible without moving the upper arms from the arm-cushions. During *expiration* the arms are brought back to the vertical position.

Effect: on the muscles of the anterior (inner) side of the arms. The flexors of the wrist fix the hand and the dorsal muscles counteract the inclination of the trunk to bend forward.

Muscles in activity: the *biceps brachii*, *brachialis internus*, *brachio-radialis* and the *pronator teres*. The wrist is fixed by the *radialis internus*, *palmaris longus* and *ulnaris internus*.

A 10.

Forearm-extension.

The bent arms are to be extended in the elbow-joints. The apparatus is adjusted in the same way as in A9. The arms are bent at an angle, and the handles loosely held by the flat, forward turned hollow of the hand, so as to leave them some play.

During *inspiration* the arms are stretched, and during *expiration* brought back to the angular position.

Effect: on muscles of the outer side of the upper arm. The flexors of the wrist fix the hand, the broad dorsal muscles hold the upper arm against the arm-cushion.

Muscles active: the *triceps extensor*, *anconaeus quartus*. The hand is fixed by the *radialis internus*, *palmaris longus* and *ulnaris internus*.

A 11.

Hand-flexion and extension.

Hand-flexion. The bows with the handles are set obliquely upwards. The forearms lean on the table so that the wrists are in a line with the axis of the apparatus. The backs of the hands are turned upwards and the fingers clasp the handles. The forearms are to be fixed by means of the movable leather-covered iron-clasps.

During *inspiration* or *expiration* the handles are pressed downward. During *expiration* or *inspiration* they are brought upward again, by the patient's slowly yielding to their pressure.

Hand-extension. The bows are turned straight downwards. The forearms are placed and the handles held, as above.

During *inspiration* the handles are moved upwards; during *expiration* they are slowly lowered. Hand-flexion acts on the muscles of the inside of the forearm; hand-extension on the muscles of the outside of the forearm.

Flexors: the *radialis internus*, *palmaris longus*, *ulnaris internus*, *flexores digitorum*.

Extensors: the *radialis externus longus* and *brevis*, *ulnaris externus*.

A 12.

Finger-flexion and extension.

The movement is made by means of an iron-bow, in the middle of which a fork-shaped iron piece is fastened. Between the two prongs of the fork, a small piece of leather is stretched, against which the top

joint of the finger is pressed. The lever for finger-flexion is to the right, and that for finger-extension to the left. In consideration of the unequal strength of the flexors and the extensors these levers are very differently weighted. The lever which is to be used is joined to the bow by means of a spring-bolt. In finger-flexion the bow stands horizontally, in finger-extension, vertically. That the corresponding spring-bolt on the other side of the bow may not hinder the free play of the latter, the bolt is drawn back, and turned at an angle of 90° .

The forearm, as well as the hand, is so placed on the small table-plate, that the joint which has to be exercised is in the line which connects the two axes of the apparatus. This is the case when the finger is bent downwards at a right angle in the said joint and the hand so far drawn back that the downward bent finger touches the edge of the table-plate. The iron fork is adjusted to the length of the finger so that the terminal phalanx rests on the extended leather.

To exercise the muscles of the thumb, the hand is placed between the two wooden splints and the terminal phalanx of the thumb is placed upon the fork-leather (in extension) and under it (in flexion). In extension and abduction of the thumb, the lever for finger-flexion must be used, and in flexion, adduction and opposition that of finger-extension. But in the latter case the ordinary counter-balance of the lever is too small, wherefore an additional weight belonging to the apparatus is attached to the original one. To give more room to the thumb, the table-plate is moved a couple of inches backwards and is fastened by the set-screw.

The rhythm of the movement must coincide with rhythm of the breathing.

Muscles in activity: *flexors* of the first phalanges: the *interossei* and *lumbricales*; of the second phalanges: the *flexor*

sublimis digitorum; of the third phalanges: the *flexor profundus digitorum*. *Extensors* of the first phalanges: the *extensor communis digitorum*, *extensor indicis proprius*, *extensor digiti quinti proprius*; of the second and third phalanges: the *interossei* and *lumbricales*. In thumb-extension and abduction: the *abductor poll. longus et brevis*, *extensor poll. longus et brevis*. In thumb-flexion, adduction and opposition: the *flexor poll. long. et brevis*, *adductor poll.*, *opponens poll.*

B. Active movements of the legs.

B 1.

Hip-flexion.

The thigh is to be bent upwards and forwards. The patient places himself with one thigh on the seat and lets the other leg hang down. The hip-joint of the latter must be in a line with the axis of the apparatus. The movable knee-support is to be fastened so that it rests on the anterior part of the thigh just above the knee-pan. The arms lean on the handles of both sides and help to give the body a firm upright position.

During *inspiration* the thigh is bent at an acute angle upwards against the pelvis, by simultaneous flexion of the knee-joint; during *expiration* the thigh is slowly lowered with simultaneous extension of the (lower) leg, until the whole limb hangs straight down.

Effect: on the muscles within the pelvis, on the anterior part of the spinal column, as well as on the hip and on the front of the thigh.

Muscles active: the *iliopsoas*, *tensor fasciæ latæ*, *rectus femoris* and *sartorius*.

B 2.

Hip-extension.

The extended leg is to be moved downward and backward.

The patient lies down on the inclined plane so that one leg can move freely in the opening in the middle of it; the foot is put into a foot-strap so that the whole leg is suspended in it. The other leg rests on the inclined plane with the sole pressed against the foot-board.

During *inspiration* the leg is moved downward as far as possible without bending the knee; during *expiration* it is moved upward again.

Effect: on the glutæal muscles as well as on the muscles of the back of the leg. The muscles of the lumbar region fix the pelvis.

The movement is executed chiefly by the *glutæus maximus* (the posterior part of the *glutæus medius* and *minimus*, however, help in the movement), as well as by the flexors of the knee which arise from the tuberosity of the ischium *i. e.* by the *biceps*, the *semimembranosus* and the *semitendinosus*; the fibres of the *gastrocnemius* also contract. Finally the extension of the hip-joint is checked by the *ligamentum iliofemorale*. The patient might be tempted to extend the exercise by bending his knee, but this is not permissible, as it does not enter into the plan of the movement.

B 3.

a. Hip-knee-flexion; b. Hip-raising.

- a. Simultaneous flexion of the hip-and knee-joint;
- b. repeated raising and lowering of one hip.

a. The patient places himself on the foot-boards, pressing the handle down with his right hand to raise the foot-crutch; then the leg which has to execute the movement is so placed in the crutch that the cushioned parts of the latter clasp round the instep and rest on it; now the patient lets the handle go, grasps the side-supports, stretches out his leg and sinks his foot between the foot-boards.

During *inspiration* the thigh and the leg are simultaneously bent, until the former forms a right angle with the pelvis; during *expiration* the leg is again slowly straightened.

b. *Hip-raising*. The same starting position as in hip-knee-flexion. The thigh and leg are kept straight during the whole movement. During *inspiration* the hip indicated in the prescription is raised as far as possible without bending over to the other side; during *expiration* it is lowered again.

Effect: on the muscles within the pelvis and on the anterior portion of the spinal column, as well as on the hip and posterior part of the thigh.

Muscles active for the flexion of the thigh: the *iliopsoas*, *tensor fasciae latae* and *sartorius*; and *for the flexion of the (lower) leg*: the *biceps femoris*, *seminembranosus* *semitendinosus* *sartorius* and *gracilis*. The *tibialis anticus*, *extensor longus digitorum*, *extensor longus hallucis* and *peroneus tertius* hold the foot bent upwards, so that the foot-crutch does not slip off. A large number of muscles contract in the leg on which the weight of the body rests during the movement, especially the *glutæus medius* and *minimus*. These two latter muscles are especially exercised by hip-raising, since they must contract to their utmost; in hip-knee-flexion this is not the case, as they contract only enough to fix the pelvis. The *sacrolumbalis* and *obliqui abdom. ext. and int.* on the side of the movement are also active: in hip-knee-flexion for fixing; in hip-raising, taking part in the movement.

B 4.

a. Hip-knee-extension; b. Hip-sinking.

a. Simultaneous extension of hip-and knee-joints.

The patient places himself on the foot-boards and holds the side-supports; then one foot is placed on the iron-step which for convenience's sake is fastened by a check-hook near the floor. As the patient steps on it, the hook gives way. While yielding slowly to the pressure of the iron-step, the patient allows the knee to be pressed upwards till the thigh forms an acute angle with the trunk, or so far that at the highest position of the knee, the pressure of the iron-step is still felt. If the step should not rise high enough for this to be the case, that could be remedied by adjusting the spring-bolt in a lower hole of the chain-pulley. At the close of the movement the hook is moved forward over the lever-arm of the step and the foot is put down when the hook has caught. This must be done cautiously, because the lever of the apparatus is heavily weighted, and if the step should be allowed to knock against the hook, the apparatus might be damaged.

During *inspiration* the thigh and the leg are stretched out. During the following *expiration* the knee and hip-joint are bent again, the patient very gradually yielding to the pressure of the iron-step.

Effect: on the glutæal muscles as well as on the muscles of the anterior part of the thigh and of the posterior part of the leg.

b. *Hip-sinking.* Repeated sinking and raising of one hip. The leg is to be kept outstretched during the whole movement. During *inspiration* the hip is lowered, during *expiration*, raised.

Effect: on muscles within the pelvis and on the inside of the thigh, as well as on certain abdominal and dorsal muscles, all on the same side as the leg on which the patient leans. Also on the hip-muscles of the other side.

Muscles acting on the hip-joint: the *glutæus maximus* and *medius* (posterior third). *On the knee-joint:* the *quadriceps extensor*. The ankle is fixed by the *triceps suræ*, *peronæus longus* and *brevis*, *tibialis posticus*. *Muscles acting in hip-sinking:* the *pectineus*, *adductores*, *sacrolumbalis*, *obliquus abdom. ext.* and *intern.* On the opposite side: the *glutæus medius* and *minimus*.

B 5 a.

Leg-adduction (sitting).

The legs which are outstretched and wide apart are to be drawn together (adduction).

After seating himself and placing the inferior part of the lower leg in the foot-crutch, the patient takes the joining-strap in his right hand and brings his legs a little nearer together, so that the strap can be loosened. During *inspiration* the legs are moved inwards, during *expiration*, outwards.

Muscles active: the *pectineus*, *adductores* and *gracilis*.

B 5 b.

Leg-adduction (half-reclining).

The bent legs which are held wide apart are to be drawn together.

The patient places himself far back on the seat, leans his back against the cushioned support, puts the cushion at his neck, and his feet on the foot-board on a level

with the seat. From the middle, the surface of the foot-board slants to both sides. Thus, when the knees are moved apart (abduction), the feet can be bent outwards, which prevents too great a strain on the ankle.

The foot-board can be removed while the patient places himself in the apparatus. It is so adjusted that the legs form right angles at the knee-joints. The knees are moved outwards, the cushioned knee-clasps laid over them and the brass sockets fastened on the lever so that the straight part of the knee-clasp is at right angles with the plane in which the bent leg is placed.

During *inspiration* the knees are slowly drawn together and during *expiration* again moved outwards.

B 5 b acts on the same muscles as B 5 a. As the pressure in the abdomen is lessened by the reclining and supported position, this movement (but not the preceding one) can be used in herniae and especially pelvic disorders.

Professor VON PREUSCHEN has made the observation that the *musculus levator ani* contracts synergetically with the adductors of the leg, especially in simultaneous elevation of the pelvis from the seat *i. e.* by contraction of the extensors of the back and hips. This would afford a means of strengthening the floor of the pelvis. This can especially be attained by B 5 b, where, by the reclining position of the body, the abdominal muscles are in repose, and therefore do not counteract the contraction of the muscles of the bottom of the pelvis.

B 6.

Leg-abduction.

The legs, held close together, are to be drawn apart. After the patient has seated himself and placed

the lower part of his legs in the foot-crutch, the legs are moved outwards during *inspiration*, and moved together again during *expiration*.

Muscles active: about the posterior third of the *glutæus medius* and *minimus*, the *pyriformis*, *obturator internus* and the *gemelli*.

B 7.

Velocipede-motion.

As in A 7, A 8 b, B 11 there is no mechanism peculiar to this apparatus with the object of causing a determinate resistance during the movement. A fly-wheel is set in motion by treadle-movement, in a sitting position.

The seat is screwed so high that when both treadle-boards have the same height and the feet rest on them, the thighs of the patient are in an horizontal position, but the legs stand vertically on the boards. If the seat is screwed higher, increased tension is attained, if screwed lower, greater flexion of the joints.

After the checking-bar has been pushed forward, the wheel is set in motion by the right hand, and the motion maintained by treading-movement. This is to be continued till a slight weariness is felt in the legs. Rapid motion requires increased muscular effort and easily causes dyspnæa.

Effect: increased mobility of the hip-knee-and ankle-joint, alternate tension and relaxation of several muscles, causing increased flow of blood to the legs.

The muscles called into action to sustain the movement are the large glutæal muscles and the muscles of the anterior part of the thigh.

Muscles active: the *glutæus maximus* and the *quadriceps extensor*.

B 8.

Leg-rotation.

The wheeled chair is pushed so far back that the legs are stretched out when the feet rest on the iron-soles. *Inspiration* takes place while the feet are as much as possible turned outwards; *expiration* while they are moved back to their original position. The legs are to be kept stretched.

The common habit of turning the feet inward while walking makes it seem superfluous to give a special exercise for the muscles which turn the leg inward, and which, besides, are brought into action by the apparatus B 1 and B 3. Should there, however, be reason to have an exercise for turning the leg inwards, this might be effected, first with one leg and then with the other, the right foot being placed in the left iron, and the left foot in the right iron.

Effect: chiefly on the hip-joint and the muscles behind and below it, of which two have their origin within the pelvis. The effect on the foot-joint is insignificant; not a few of the muscles of the anterior and exterior portion of the (lower) leg are, however, brought into action to fix the foot. The movement diverts blood from the organs of the pelvis.

Muscles turning the leg outwards: the *pyriformis*, *obturator internus*, *gemelli*, *quadratus femoris* and *obturator externus*. In a sitting position the *pyriformis* might be but little called into action as a rotator, since it works along the thigh. Several muscles contract to fix the foot: the *extensor digitorum longus*, *peronæus tertius longus* and *brevis* as well as the *abductor digiti quinti*.

Muscles turning the leg inwards: the *glutæus medius* and *minimus*, about the anterior two-thirds of these two and the *tensor fasciæ latæ*. The foot is held inwards by the *tibialis anticus* and *posticus*, and the *abductor hallucis*.

B 9.

Knee-flexion.

The patient seats himself so far into the chair that the knee-pans are on a level with the axis of the apparatus. The legs are so placed on the cushioned crutches of the swing-bar, that these are just above the heels. Then the closing mechanism of the movable frame is undone with the right hand, so that it can take the horizontal position and that the legs are stretched to their full length. The knee-support is so adjusted that the thighs are held against the seat, the hands resting on them; the *patient must take care not to lean his arms on the side-supports of the apparatus*. During *inspiration* the knees are bent till the legs are at an acute angle to the thigh; during *expiration* the legs are brought back to the horizontal position, gradually yielding to the pressure of the frame.

The angle of flexion of the leg can be seen by means of the movable scale of the circular arc fastened on the lever and by the fixed index.

N. B. The swing-bar is fastened by the bolt only when one leg alone is to make the movement, or when the legs are so unequal in strength that they cannot balance the swing-bar.

Effect: on the muscles of the posterior portion of the leg: the *biceps femoris*, *semimembranosus*, *semitendinosus*, *gracilis*, *sartorius*.

B 10.

Knee-extension.

The patient seats himself so far into the chair that the knee-pans are on a level with the axis of the apparatus. The legs are placed behind the swing-bar so that the front part of the legs just above the ankles touches the cushioned crutches of the swing-bar. The closing mechanism of the movable frame on which the legs rest is then undone with the right hand. During *inspiration* the knees are stretched until the lower legs have an horizontal position; during *expiration* they are brought back to the vertical position.

N. B. The swing-bar is fastened with the bolt only when one leg alone is to make the movement, or when the legs are of very unequal strength.

Effect: on the muscles of the anterior portion of the thigh: the *quadriceps extensor eruris*; synergetically with this muscle the *tensor fasciæ latæ* contracts. If this muscle and the *rectus femoris*, the former through its origin from the *spina ant. sup. ossis ilium*, the latter through its origin from the *spina anter. inf. ossis ilium*, should tend to draw the pelvis forward, this is prevented by the contraction of the *gluteus maximus*. Weak persons and persons unaccustomed to bodily exercise, especially women, also contract the abdominal muscles, chiefly during the latter part of the movement. The pressure in the abdomen thus produced, causes pain in the pelvic organs when these are swollen and sensitive. Therefore persons suffering from pelvic affections should not make the effort necessary to raise the legs to an horizontal position.

B 11.

Foot-flexion and extension.

As in A 7, A 8 b, B 7 and B 12 there is no mechanism peculiar to this apparatus with the object of causing determinate resistance during the movement. The flexion or tension of the foot sets a fly-wheel in motion and the muscular effort is in proportion to the number of rotations. This is indicated by an index moving along a scale, of which the figures show the number of rotations by adjusting the connecting-rod in differently marked holes in the crank-disk, a varying range of movement in the ankle is obtained for extension, and flexion, as the different figures correspond to certain angles; by lengthening or shortening the connecting-rod the entire angle can, as occasion requires, be unequally divided for flexion and extension. The apparatus is adjusted for ordinary cases; the position of the movable socket on the rod, that is, the length of the latter, is indicated by a corresponding notch. If the foot-flexion is required stronger or the extension slighter, the connecting-rod is shortened, but if the extension is desired stronger and the flexion slighter, the rod is lengthened.

The wheeled chair is pushed so far back that the knees are stretched when the legs rest in the cushioned bows just above the heels; and the bows are adjusted higher or lower so that the ankles are in a line with the axis of the apparatus. The feet rest against the movable frame and the foot-straps are drawn over them.

The patient sets the fly-wheel in motion with his hand, and the motion is maintained at first by his drawing the movable frame towards himself (foot-flexion) and further by pressing it backwards with his soles (foot-extension), — each movement 25 to 100

times, or until some slight fatigue is perceptible. When the index has moved over the entire scale, the motion of the fly-wheel is reversed, and the index then goes back.

Extensors: the *gastrocnemius*, *soleus* (working at the same time as adductors and supinators) *peroneus longus* (working both as abductor and pronator).

The *tibialis posticus* places the foot at right angles and adducts it. The *peroneus brevis* also places the foot at right angles, but abducts it.

Flexors: the *tibialis anticus* (both supinator and adductor) *extensor hallucis longus*, *extensor digitorum longus* and the *peroneus tertius* (the last two both pronators and abductors).

B 12.

Foot-circumduction.

The toe is so moved as to describe a circle. As in A 7, A 8 b, B 7 and B 11 there is no mechanism peculiar to this apparatus with the object of causing a determinate resistance during the movement. A fly-wheel is set in motion by the flexors or extensors of the foot, exactly as in B 11, but in B 12 the foot has to make at the same time a rotary movement.

The wheeled chair is pushed back so far that the leg, when resting in the cushioned heel-crutch, can be kept stretched. The iron-sole to which the foot is screwed, can be moved forwards or backwards, and the heel-crutch can be raised or lowered so that the ankles are in a line with the horizontal axis of the apparatus. The width of the circle which the toe describes during the movement depends on the adjustment of the graduated transverse bar, which is held by the axle of the wheel.

This is set in motion by the hand, and the motion maintained by active flexion or extension of the foot.

The best way is to make 20 to 50 rotations in one direction (sustaining the movement by extension of the foot) and afterwards the same number of rotations in the opposite direction by bending the toe forward.

Effect: on muscles of the lower leg; those of the posterior part stretch the foot, and those of the anterior part bend it. The circumduction mollifies the capsules and ligaments of the ankle-joint. When the thigh is held so that the movement is not conveyed to the hip-joint, the effect on the foot is remarkably greater.

Muscles active: the same as in B 11.

C. Active movements of the trunk.

C 1.

Trunk-flexion (sitting).

The upper part of the trunk is to be bent forward from a sitting and backward reclining posture.

The patient seats himself on the chair and puts his feet behind and under (occasionally between) the cross-bars at the foot of the apparatus; the leather-straps are laid over the shoulders, under the arms and crossed on the back so that the left hand holds the right strap and the right hand the left strap. Then the patient leans against the back support and draws the straps firmly about him. *First an inspiration.* During *expiration* the patient bends forward, and the back which was at first straight, is finally bent as strongly as possible; *inspiration* follows during the straightening of the back, and during *expiration* the patient slowly reclines against the back-support.

Thus the bending forward takes place during deep *expiration*; during the following phase of the movement, straightening the back, *inspiration* is possible only at the beginning, since later the abdominal muscles are in such a state of tension that *expiration* becomes a necessity. The next inspiration follows while the patient sits leaning backwards.

Effect: partly on the abdominal muscles, partly also on those of the inside of the pelvis, of the anterior

part of the spinal column and of the thigh. Powerful expiration-movement.

The movement is made partly by the abdominal muscles, the *rectus abdominis*, *obliquus externus* and *internus*, as well as *transversus*, partly on the muscles effecting the bending forward of the pelvis, the *iliopsoas*, *tensor fasciæ latæ* and *rectus femoris*.

C 2.

Trunk-extension (sitting).

The patient, sitting on a chair in a forward bent position, is to straighten the upper part of the trunk and bend it backwards, by overcoming the resistance of the apparatus.

The patient seats himself so that his feet rest on the movable, slanting foot-board, with the shins against the padded cross-bar, bends as strongly as possible forward and places the leather-strappings so that the cross-strap goes right across the shoulderblades; then one of the straps is grasped from each side and held so tightly that they do not relax during the movement.

During *inspiration* the trunk is stretched and bent backward till the back touches the support; during *expiration* the trunk is raised and bent as far as possible forward, while the straps are continuously held tightly.

Effect: on a great number of muscles at the back of the body, from the neck down to the calves.

Muscles active: the *erector spinæ*, *trapezius*, *rhomboides*, *levator anguli scapulæ*, *latissimus dorsi*, *gluteus maximus*, *biceps femoris*, *semimembranosus* and the *semitendinosus*. The knee-joint is held by the *quadriceps extensor*, (with exception of the *rectus femoris*) and the ankle-joint by the *triceps suræ*, *tibialis posticus*, *peroneus longus et brevis*.

C 3.

Trunk-raising and flexion.

The trunk is to be bent forward from a recumbent into a sitting posture.

After the prescribed angular position has been given to the plane by lowering its upper, movable part, the patient places himself so that his back rests on the upper, slanting part, and his legs on the horizontal part of the plane. The legs are held by means of a strap just above the knee-pans, the hands put firmly against the sides.

The patient inspires while reclining; and expires while raising himself to a sitting posture always with stretched body, and further with bowed head bending forward as far as possible. While he raises himself again the second inspiration follows, and while he slowly sinks back on the inclined plane, the second expiration. Inspiration again takes place while the patient is reclining, and the movement recommences during expiration.

Effect: partly on the abdominal muscles, partly on the muscles inside the pelvis, and on the anterior portion of the spine. The neck-muscles move and fix the head. As the respiratory muscles are heavily taxed by this movement, inspiration must take place during the pauses when they are relaxed.

The abdominal muscles, the *rectus abdominis*, *obliquus externus* and *internus* as well as *transversus* work almost only to (fix) the body until the upright position is attained whereas the raising of the body is effected by the *iliopsoas*, *tensor fasciæ latae*, *rectus femoris* and at the beginning of the movement also by the *pectineus* and *adductor longus*. The *vastus internus* and *externus* contract if the knee be not held firmly enough against the plane.

When the patient bends forward, the above-mentioned abdominal muscles contract, but with little energy, because gravitation co-operates in bending the trunk forward. This lessening of the activity of the flexors at the end of the movement takes place in a considerably smaller degree when using the apparatus C 1.

C 4.

Trunk-extension (long-sitting).

The patient seated on the plane in a forward bent position with legs extended, is to stretch and bend the trunk backwards.

The patient places himself with outstretched legs on the plane, opens the closing mechanism with his left hand, and with the other sets in motion a regulating wheel on the right to push the foot-board against the feet. The straps are put on, the hands pressed to the sides so that the thumbs firmly hold the lower straps coming from the back. During *inspiration* the patient leans backwards from 45° to 60° ; during *expiration* he raises himself into a sitting position and bends the upper part of the body forward as far as possible without bending the knees.

Effect: on a large number of muscles at the back of the body from the neck down to the calves. The resistance of the apparatus is sufficient for powerfully calling all these muscles into action, at least in an upright position; but, in proportion as one leans backward the weight of the body is cooperative until it balances the resistance of the apparatus, and soon, especially in heavy persons, so far exceeds it that such patients must contract their abdominal muscles to hold themselves up. As soon as this is the case the movement backward should be checked. The said inconvenience appears less in the apparatus C 2, but C 4

has a secondary effect which C 2 does not offer; that is, by the reclining starting-position, the apparatus causes strong tension of the large glutæal muscles and of the muscles of the back of the thigh. Moreover, in proportion with the leaning backward, the pressure of the straps acts more strongly on the muscles which support the shoulders.

Muscles active: the same as in C 2.

C 5.

Trunk-extension (standing).

The patient standing bent forward is to stretch the trunk backward.

The patient places himself upon the foot-board of the apparatus with his legs against the cushioned cross-bar, which is to be so adjusted that it touches the upper third of the thigh. After the leather-straps have been put on, the hands are pressed to the sides, and the thumbs should hold the straps so that they do not slide upward. That the straps may be easily put on and taken off, the lever of the apparatus is fastened in an horizontal position by a catch. During *inspiration* the upper part of the body is bent backward 45° without removing the thigh from the cross-bar or bending the knees; during *expiration* the patient bends as far as possible forward.

Effect: on a number of muscles at the back of the body from the neck down to the calves.

The back-extension is effected by means of the *erector spinæ*; the weighted shoulders are supported and fixed by the *trapezius*, *levator anguli scapulæ*, *rhomboidei* and by the *latissimus dorsi*; the pelvis is raised by the *glutæus maximus*, *biceps femoris*, *semimembranosus* and *semitendinosus*.

C 6.

Trunk-sideways-flexion.

The patient places himself with his back against the padded cross-bar and bends his arms round its ends. Since the lumbar region possesses the greatest flexibility, it is a matter of course that the movement should cause the greatest flexion in this part of the spine. Therefore the seat must generally be so adjusted that the axis of the apparatus is nearly on a level with the middle of the lumbar region of the spinal column. The padded cross-bar must correspondingly be so far pushed upwards from the axis that it fits comfortably in the somewhat sharply flexed arms. For middlesized persons the adjustment in the 4th hole from the bottom is generally suitable, and for shorter persons the 3rd or 2nd. If the effect of the flexion is to benefit a superior portion of the spine, as in treating spinal dorsal curvature, the seat is screwed down, so that the axis comes on a level with the height of the curvature, while the cross-bar is to be adjusted correspondingly for the shoulders. In consideration of the smaller flexibility of the superior part of the back, the range of movement becomes slighter and the resistance greater. The instructor must often assist by exercising a pressure with his hand on the convexity of the curvature. When, as in such cases, the movement is to be made unilaterally, the cross-bar should be inclined to the left for flexion to the right, and conversely.

If it seems desirable to lessen the angle of side-flexion, it is only necessary to put a peg in the fork-shaped iron bow projecting from the foot-piece upward and holding the lever, whereby the latter is prevented from sinking lower.

In this movement, inspiration during the movement of greater effort is to be recommended, so that the side of the thorax which does not work may be extended as much as possible. Therefore during inspiration the patient raises himself from the inclined starting position and leans over on the other side; during expiration he returns to the starting position.

Effect: on the dorsal and abdominal muscles of the side which makes the movement; as well as on the elevators of one shoulder and on the depressors of the other. The flexors of the arm have to hold the lever.

Purely Lateral flexors: the *quadratus lumborum*, *serratus posticus inferior*, *intertransversarii*; **muscles which have also a backwards bending component:** the *ileocostales lumborum et dorsi*, the *longissimus dorsi* (lateral insertions). The *levatores costarum* must act as active ligaments, that is, they strengthen the junction between ribs and vertebrae. Besides this, there is a force required to approach the ribs to each other; it may be brought about by contraction of the *intercostales*, as well as the accessory group *iliocostalis dorsi*. Of the abdominal muscles only the posterior portions of the *obliquus externus* and *internus*, which pull the lowest ribs down towards the edges of the hip-bones, seem able to contribute in a higher degree to the side-flexion of the trunk.

By its cross-bar the apparatus first acts on the arms and through them on the shoulder-blades, of which it pulls one upwards and the other downwards. Against this action they are fixed on the active side by the *latissimus dorsi*, *teres major* and *minor*, *rhomboidei*, the inferior portion of the *trapezius*, *pectoralis major* and *minor*, and on the passive side by the superior portion of the *trapezius* and by *serratus anticus major* as well as by the *levator anguli scapulae*.

C 7.

Trunk-rotation.

The patient performs a rotation of the upper part of the trunk, while the pelvis is fixed.

The patient seats himself, places his feet on the foot-board and after the knees have been fastened by means of a strap, the arms are laid in the end bows of the padded cross-bar. The latter must be adjusted as high as possible without causing inconvenience. If the movement is to be taken unilaterally, so, for instance, that the rotation is to be made to the right, the patient must sit down turned to the left, so that the axle which carries the cross-bar has to be turned to the right, and conversely, when the rotation is to be made to the left. By means of a spring-bolt the axle can be adjusted according to the different starting positions.

Inspiration takes place in the starting position. During *expiration* the upper part of the trunk is rotated as far as possible to the opposite. During the following *inspiration* the patient returns to the starting position, slowly yielding to the pressure of the cross-bar. When the movement has been made several times towards one side, the spring-bolt should be taken out, the cross-bar turned and adjusted for the other side, and an equal number of rotations made to the opposite side.

Effect: as well on the abdominal as on the dorsal muscles. In turning to the right, the right arm is fixed by the dorsal muscles and the left arm by the pectoral muscles; in turning to the left the right arm is fixed by the pectoral muscles and the left arm by the dorsal muscles.

The rotation is chiefly accomplished in the dorsal vertebrae as the capacity of rotating is excessively small in the lumbar vertebrae.

The long band of muscles which winds itself from one side of the lumbar region and pelvis round the abdomen and thorax, until finally reaching the shoulder-blade and upper arm of the same side, causes the rotation of the trunk. When the rotation is made to the right this series from below upwards consists of the following muscles: the *obliquus abdominis*

internus, *transversus* and *serratus posticus inferior* on the right side; the *obliquus externus*, *serratus anticus major*, *rhomboidei*, *multifidus spinæ*, and the *semispinalis dorsi* on the left side; the *trapezius*, *rhomboidei* and the *latissimus dorsi* (upper portion) on the right side.

In addition, the *pectoralis major sinister* contributes by drawing the left upper arm forward, and the *latissimus dorsi dexter* by drawing the right upper arm backward. The correspondent series of muscles, situated on the opposite sides rotates the trunk to the left.

C 8.

Pelvis-rotation.

The patient has to turn the inferior part of the trunk, while the upper part is fixed. He places himself on the seat and puts his feet on the foot-iron; after the strap has been fastened across the knees, the padded cross-bar, which is to be adjusted as high as possible, is fixed between the arms (which close round it) and the back.

If the movement is to be made unilaterally, for instance to the right, the seat must be adjusted to the left for the starting-position, and conversely when the movement is to be made to the left. The seat is fastened in the starting-position by means of a spring-bolt.

First there is an *inspiration* in the starting-position. During *expiration* the seat with the pelvis fixed on it is turned round as far as possible in the opposite direction; during the following *inspiration* the patient returns to the starting-position, slowly yielding to the turning force of the seat. When the movement has been made many times in one direction, the spring-bolt is taken out and the seat so readjusted and fastened that the movement can be made in the other direction.

Effect: on the abdominal as well as on the dorsal muscles. By fixation of the upper arms, the thorax-muscles hold the transverse lever between the upper arms and the back.

Muscles active: see statements appended to C 7; the *pelvis-rotation to the right* is effected by means of the same muscles as *trunk-rotation to the left* and *vice versa*.

C 10.

Neck-extension.

The head is to be bent backwards.

By this apparatus the muscles which bend the head forward and sideways can also be exercised, but generally the *extensors* of the neck most need strengthening.

The head-plate, the side-handles of which are grasped with both hands, is adjusted so as to be nearly on a level with the crown of the head and with the padded side towards it, while the patient places himself so far from the apparatus that the string to which the head-plate is fastened, is stretched even when the head is strongly bent forward. To make the position steadier one foot should be put forward.

If the *flexors* of the head are to be exercised, the patient turns round and places the cushion against his forehead. Then the starting-position would be a strong backward-flexion of the head. The lateral flexion is made so that one side is turned to the apparatus, and with the opposite hand the cushion is held to the ear of the same side. The starting-position should then be a strong lateral flexion of the head, towards the apparatus.

From the starting-position the head is bent as far as possible away from the apparatus. A very slight

movement of the back is allowed; the movement should be made almost exclusively by the head.

The extension of the head backwards is done during inspiration; the flexion forwards and sideways during expiration.

The extensors of the neck: the *clavicular portion* of the *trapezius*, the *splenii capitis* and *cervicis*, *iliocostales cervicis*, *longissimi capitis* and *cervicis*, *recti capitis posteriores majores* and *minores*. **Lateral flexors of the head:** the above mentioned muscles when contracted only on one side, as also the *intertransversarii* and *rectus capitis lateralis*. **Forward flexors of the head:** the *sternocleidomastoidei*, *scaleni*, *longi colli*, *atlantis* and *capitis* and the *rectus capitis anterior*.

D. Balancing movements.

The apparatus of this and the following groups E, F, G, H and J are all set in motion by means of a motor.

D 1.

Trunk-balancing.

The seat of the apparatus is set in a balancing motion, either equally to both sides, *D 1 b* (bilateral), or only to one side, *D 1 u* (unilateral).

When the movement *D 1 b* is to be performed the movable arms of the connecting-rod must be placed in such a way that the sliding socket *B* covers the brass-plate *B*.

When the movement *D 1 u* is to be performed, the inner edge of the socket *U* must be adjusted to the degree on the scale of the connecting-rod which corresponds to that given on the prescription. This figure at the same time indicates how the crank-pin at the posterior part of the apparatus is to be adjusted on the scale there, by which the inclination of the seat is determined.

Since two different movements can be given to the seat, and the patient can place himself in three different positions, a series of movements with very different effects are possible and must therefore be carefully distinguished.

In writing the prescription:

D 1 b means equal balancing of the seat to both sides, when the patient is to be so placed as to turn his side to the apparatus or to the handle at the back.

D 1 b forward means equal balancing of the seat to both sides, while the patient is sitting turned forward (with his back to the handle).

D 1 u R means balancing of the seat to one side only, while the patient sits with his *right* side turned to the apparatus.

D 1 u L means balancing of the seat to one side only while the patient sits with his *left* side turned to the apparatus (or the handle).

D 1 u forward means balancing of the seat to one side only, while the patient is placed so that he is turned forward (with his back to the handle).

The weight of the body holds the pelvis and the thighs on the seat while the balancing movement forces the patient to balance the trunk, by which, according to the position and kind of movement, different muscles are brought into activity.

The muscles exercised are:

By *D 1 b* the lateral flexors of the trunk, as there is alternate contraction of the muscles of one side and tension of those of the other.

Muscles active: see C 6.

By *D 1 b forward* the flexors and extensors of the trunk by alternate contraction and tension of both groups of muscles.

Muscles active: see C 1 and C 2.

By *D 1 u R* the *left* lateral flexors of the trunk during corresponding tension of the muscles as well as the tendons of the right side, whereby lateral flexion of the lumbar region with the convexity to the *right* takes place.

By *D 1 u L* the *right* lateral flexors of the trunk during corresponding tension of the muscles, as well as the ligaments of the left side, while lateral flexion of the lumbar region with the convexity to the *left* takes place.

The last two movements are used only in the treatment of lateral curvatures of the spine in which they are exceedingly effective.

Muscles active: see C 6.

By *D 1 u forward* the abdominal muscles and the flexors of the thigh with corresponding tension of the lumbar region and hip-extensors.

Muscles active: see C 1; for *muscles which are extended* see B 2 and C 2.

The flexors of the knee contract at every backward balancing to fix the thighs on the seat.

During all these movements the viscera of the abdomen are compressed and rubbed against each other whereby the circulation of blood and lymph is accelerated and the activity of the intestinal muscles increased.

The patient must sit with knees apart and hands resting on the hips, holding his body and head as quiet and erect as possible. The movements should last from 1 to 3 minutes.

D 2.

Pelvis-circumduction (transversal sitting).

The seat of the apparatus is moved so as to incline successively in all directions. The numbers on the prescription refer to the figures on the graduated cross-bar on the foot-piece of the apparatus, which conveys the movement to the seat. According as the

cross-bar is adjusted, the force of the movement varies. The inclination of the seat becomes greater the further the end of the cross-bar which carries the vertical lever of the rolling seat, is removed from the axis of the apparatus.

The apparatus stands still when the fork-shaped belt-shifter is in the middle groove; if it is adjusted to the right, the inclination of the seat passes from right to left, and conversely when it is adjusted to the left. The patient should sit with his right side towards the beltshifter so as to be able to grasp its handle with his right hand. During the movement the upper part of the body is to be held as quiet and upright as possible, since by such a position the intended muscular effect is brought about much more perfectly and uniformly than when the head and upper part of the body move in all directions which in many people causes giddiness. The movement should last one minute towards each side.

In order to preserve his equilibrium the patient must successively call into action all the muscles that balance the upper part of the body on the pelvis, or the whole trunk on the seat and that in proportion to the inclination of the seat.

When the latter is inclined straight forward or backward, balance is obtained partly by bending the lumbar region with the convexity in the same direction as the inclination, partly by movement (flexion and tension) in the hip-joint. If the inclination of the seat is straight from the right or the left, balance can be obtained only by flexion of the lumbar region with the convexity to the same side. Of late the seat has been made of two parts joined by a hinge. By placing one of the accessory wooden-pieces between the boards, an inclination of respectively, 4, 6, 8, 10 degrees is attained, so that—when the patient places himself with the bend of his knees before the opening between the

boards — his abdominal muscles are proportionally brought into greater activity, which is advantageous in the treatment of constipation.

All the various inclinations which come between the above mentioned main directions, cause flexion of the lumbar region and movement of the hip-joints, more in the one or the other, according as the momentary inclination approaches the one or the other main direction

The movements in the hip-joints are accomplished by means of the hip *flexors* and *extensors* (see B 1 and B 2); *the movements of the lumbar region* by the *back flexors* and *extensors* (see C 1, C 2 and C 6).

D 3.

Pelvis-circumduction (saddle-sitting).

The saddle-shaped seat of the apparatus is inclined successively in all directions. The figure on the prescription refers to the movable graduated cross-bar, the peripheric end of which is connected with the vertical lever of the saddle and conveys the movement to the latter. The more the transverse bar is lengthened by moving the peripheric end away from the driving-axle, the greater is the inclination of the saddle. The apparatus stands still when the belt-shifter is in the middle position; if it is adjusted to the right, the saddle slopes from the right to the left, and conversely if it is moved to the left.

The patient places himself astride the saddle, looking towards the sand-glass and the handle of the belt-shifter. During the movement the upper part of the body is to be kept as erect and immovable as possible. Thereby the intended muscular action is brought about much more perfectly and uniformly than

when the upper part of the body and the head are allowed to toss about in all directions, a cause of giddiness in many persons.

The movement generally lasts one minute to each side.

Respecting the effect of the movement see D 2.

As to the acting muscles see D 2.

E. Passive movements.

E 2.

Hand-flexion and extension (passive).

A round iron-bar, parallel with the table-plate of the apparatus and furnished with two movable handles, is set going up and down. The figure on the prescription refers to the position of the crank-pin on the graduated crank. The farther the former is removed from the driving-axle, the greater is the motion of the handles.

The patient places himself upon an ordinary chair, leans the forearms on the table-plate and grasps the handles, turning the backs of his hands upward. When the apparatus is set in motion these handles move up and down and cause alternate flexion and extension in the wrist, while the patient has to keep absolutely passive, contracting the flexors of the fingers only enough to hold the handles. The movement is continued for two minutes.

It causes alternate tension of the flexors and extensors, as well as of the capsules and tendons of the wrists; it increases the mobility of the wrists, the warmth and flow of blood to the hands and forearms.

Regarding the muscles extended: see A 11.

E 3.

Hand-adduction (radial flexion) and abduction (ulnar flexion) — (passive).

Two wooden plates with movable handles are set swinging in an horizontal plane.

The figure on the prescription refers to the position of the crank-pin on the graduated crank. The farther the former is removed from the driving-axle, the greater is the swing of the handles. The patient seats himself on an ordinary chair, places the forearms on the table-plate and grasps the handles which should be pushed so far in or out that the middle of the wrist is just above the fulcrum of the wooden plates.

When the apparatus is set in motion the wooden plates with the handles swing and cause alternate adduction and abduction of the hands, while the patient must keep quite passive, so that he contracts the flexors of the fingers only enough to hold the handles.

The movement is continued for two minutes. It causes alternate tension of the muscles which adduce and abduce the hands, while the latter lie with the flexor side downward. At the same time it extends various ligaments and certain parts of the joint-capsules, it causes greater mobility in the wrists, increased warmth and greater flow of blood to the hands and forearms.

Adductors (Radial flexors): the *radialis internus* and *radialis externus longus*.

Abductors (Ulnar flexors): the *ulnaris internus* and *ulnaris externus*.

E 4.

Finger-flexion and extension (passive).

The apparatus can be employed to increase the flexibility of the wrist and the finger-joints. By means of a screw and five accessory pieces which are to be used for different purposes, one of the hands or its fingers are fixed to the axle of the apparatus and this axle is turned round by the other hand by means of a lever. Thereby the fingers on the axle are clenched, when the patient pulls the lever towards himself, and extended when he pushes it away.

The five accessory pieces requisite, are marked one with *A.* two with *B.* and two with *C.*

A. is fastened on the screw for the purpose of fixing the fingers on the india-rubber covered axle of the apparatus. The letter *A.* is just above the groove, in which the index finger is to be placed; therefore this end is moved to the left when the right hand is to be treated and *vice versa*.

This piece is employed when separate finger-joints are to be bent or stretched. If one wishes to make the metacarpophalangeal joint flexible, the first phalanges are placed on the axle and fixed by means of the screw, and so on.

B., a straight piece, is fastened on the axle above the india-rubber-cover and a bent piece fastened on the screw. The palm of the hand is placed on the straight piece, and the bent piece is screwed down against the back of the hand. When the patient pulls the lever towards him, the wrist is bent.

C., a bent piece is to be attached to the axle and a straight piece to the screw.

The back of the hand is placed below in the bent piece and the straight piece is pressed against the

palm. If the patient pulls the lever towards himself the wrist is stretched.

To the left, on the axle of the apparatus, there is a round plate provided with holes, in which a spring-bolt is put. If the bolt is put in the hole No. 1, the frame with the screw is, at the beginning of the movement, in a vertical, and the hand, resting between the pieces, in an horizontal position. If the bolt is put in one of the other holes, the frame slopes more or less towards the patient. In this manner the starting position of the hand can, on beginning the movement by *B*, be more or less extended (dorsal flexion) and by *C*, more or less bent (palmar flexion). This arrangement would be necessary, if the hand had stiffened in an extended or a bent position.

During the movement the forearm rests on the table, against the wooden piece on the same side. By *C*, however it must be held centrally between both. The padded iron-arm applied to the table for fixation should not fix the arm too firmly, but so as to allow of a certain degree of motion.

E 6.

Chest-dilatation.

The apparatus in question causes passive extension of the trunk and expansion of the thorax, by means of a couple of levers which draw the shoulders backward and upward, while a cushion is pressed against the back. These horizontal lever-arms carry at one end the shoulder-crutches, and at the other are both attached to a joint sabre-shaped lever which at its free end raises a counter-balance.

This lever with its weight is in its turn, by means of a movable socket and a coupling-rod fastened to it,

joined to another vertical bar which by an eccentric wheel is set in an up and down motion; and this motion is thus conveyed to the horizontal levers with the shoulder crutches.

When the socket is fastened to the free end of the sabre-shaped lever (No. 1 on the scale) the upward motion of the crutches is smallest; the motion increases in proportion to the height of the number on the scale.

The pushing forward of the back-cushion increases the extension of the trunk and the expansion of the chest effected by the raising of the shoulders. It is pressed forward proportionally with the raising of the crutches from the adjustment No. 1 (on the sabre-shaped lever) up to No. 20; through the resistance of the back the forward motion of the back-cushion is modified, however, by the insertion of a spiral spring, the elasticity of which moderates the pressure on the back. On the other hand this pressure can be increased, as well by pushing this cushion forward on its own graduated bar (thus compressing the spring) as by the insertion of a stronger spiral spring (three sizes belong to each apparatus). The stronger springs are generally used by gentlemen, the others by ladies and children.

When the movement is to begin, the eccentric wheel is set with its greatest radius straight upwards, when the crutches are in their lowest position. The patient places himself on the seat and his shoulders in the crutches, which are pushed to the sides of the chest without pressing it. The seat is screwed so far up or down that the crutches also fit firmly in the armpits without pressure; the back-cushion should be adjusted so high that with its upper end it covers the points of the shoulder-blades, and is set at No. 1; after the socket of the sabre-shaped lever has also been placed at No. 1, the apparatus is set in motion, and the instructor alters the pressure of the cushion

and the raising movement of the crutches, until the patient finds the movement agreeable and of suitable strength. The adjustment considered suitable is noted on the prescription by means of four figures:

The first indicates the height of the seat, the *second* and *third* the height and pressure of the cushion; the *fourth* the raising of the crutches. Should the movement be too strong even though the last two figures be No. 1, further lessening of the effect of the apparatus can be obtained by raising the seat and lowering the back-cushion. The first of these measures has the effect that the crutches do not touch the arm-pits till they have completed a part of their movement upwards, while the lowering of the back-cushion transfers the pressure to softer and more yielding parts of the back. With delicate patients the best way is to take these precautions from the beginning. On the other hand the strength of the movement can be much increased by lowering the seat and raising the back-cushion.

The patient keeps quite passive and needs to inspire only when the chest begins to expand.

The movement is repeated from 5 to 10 times.

The apparatus in question is one of the most important in mechanical gymnastics. It extends the trunk in the same manner as is done by suspension on the arms, by which the natural or abnormal curvatures are diminished. All the muscles, membranes and ligaments of the walls of the thorax are extended, and, by the raising of the ribs, the latter takes a powerful inspiratory position; all these effects are still more increased by the pressure of the back-cushion. In order to give the thorax that powerful inspiratory position, it would otherwise be necessary to employ a large number of muscles which are not called into action in ordinary quiet breathing.

In consequence of sedentary work, sometimes with trunk bent forward, and compressed thorax, as in writing and such work, the muscles of the thorax are weakened and as the latter gradually stiffens, these muscles are still less called into action to cause deeper breathing, and therefore such persons easily get out of breath in taking bodily exercise. One reason of the pleasant sensation produced by chest-dilatation is, no doubt, that the thorax is considerably expanded without an exertion of the muscles.

Inspiration takes place involuntarily at the beginning of the movement and is strenghtened by the effort of the patient; but it is not possible to continue the inspiration all through the expanding part of the movement, for the abdominal muscles also are extended (passively) and hinder the further contraction of the diaphragm.

The main point, however, is that the stiff thorax is to such a degree expanded and made flexible, that the muscles which draw the ribs upwards, work more easily and can be better developed; it is further of very great importance that, by the breathing, the upper portion of the thorax is more expanded, which is necessary if the weakest part of the lungs, the apex, is to have an opportunity of being strengthened by work.

E 7.

Trunk-rotation (passive).

The seat of the apparatus is set in a sideways swinging movement on its fulcrum. The dimension of the angle described by the seat from the central horizontal line of the apparatus outwards, is determined by the adjustment of the crank-pin on the graduated scale of the crank. The angle of rotation to the right

as well as to the left increases in proportion with the higher figures.

The seat can also be made to swing towards one side only. For this purpose it should be raised about 3 cm., turned to the right or the left up to 30° , and then again pressed down, whereby a cog on the axle of the apparatus catches a corresponding notch on the under side of the seat. The patient places himself on the seat, puts his feet on the iron foot-rest, fastens the straps over his thighs and lays his arms round the padded crossbar which is to be adjusted as high as possible; the crossbar is to be fixed firmly between the upper arm and the back.

While the upper part of the body is thus fixed, the inferior part with the legs is set in a swinging movement to both sides, by which the rotatory muscles of the trunk and the ligaments of the spine are stretched alternately to the right and the left. This causes accelerated circulation in these muscles, while the mobility and development of the thorax are promoted. The viscera of the abdomen and of the chest-cavity are more or less influenced by the movements of the trunk, while these re-act on their functions and circulation. The movement being purely passive, it is particularly suitable, as generally stimulating, for feeble patients.

E 8.

Pelvis-elevation.

The apparatus has two cushioned planes of which the one in front is fixed and the one behind remains movable on an axle applied to its posterior edge, so that various sharp angles against the horizontal plane can be obtained. Its free front edge is therefore raised

to various heights above the fixed plane, and is moved up and down alternately, as soon as the apparatus is set in motion.

Two different numbers are indicated on the prescription. *The first regulates the adjustment of the crank-pin* on the crank and indicates the degree of the inclined plane; *the other determines the length of the connecting-rod*, on which depends whether, in its downward movement, the movable plane is lowered to the level of the fixed one, or stops at a certain height above it. In the former case the two figures are the same, in the latter case the second figure (that on the connecting-rod) is two or three numbers higher. It should never be lower than the first figure (that for the crank-pin), as this would check the motion of the apparatus.

The patient lies down with his chest on the fixed front plane, so that the free edge of the movable plane falls between the upper and middle third of the thigh.

The upper part of the trunk is supported on the elbows, the forearms resting extended on the front plane and the upper arms vertical.

When the posterior plane is raised, the points of support for the trunk are before the shoulder-joints and behind the hip-joints. The patient must be absolutely passive, that the trunk may hang relaxed between the four points of support. *Inspiration* takes place during the raising of the posterior plane, *expiration* during its lowering.

In the beginning the movement is made ten times, then the number is gradually increased up to fifty, a hundred or more.

In pelvis-elevation, the second figure (that on the connecting-rod) must be 2—3 numbers higher than the first (that on the crank), or else the abdomen of the patient would, in the lowest position of the movable plane, be pressed against the fixed plane, by which an

unpleasant sensation would be caused, and the effect of the movement lessened.

Pelvis-elevation lessens the pressure in the abdominal cavity, which in the highest position of the pelvis becomes even negative. The first effect of this is a facilitated access of blood to the viscera of the abdominal cavity; but as the pressure in the chest-cavity is also smaller, the flowing off is equally facilitated, so that no considerable general hyperæmia can arise, at least as long as no active digestive process is taking place. On the other hand, the hydrostatic conditions are altered by the position of the body; the pelvic organs which have generally to support the greatest pressure of blood, are now raised to the highest position, the extended, loose meshes of their network of blood-vessels can more easily empty themselves and any existing plethora be diminished. The floor of the pelvis and the organs just above it are free from the usual pressure from above; their own weight, as well as the lessened pressure in the abdominal cavity, enables them to rise within it as far as their own fixation allows. The causes which promote sinkings, displacements and abnormal shapes are thus counteracted, as well as these affections themselves, which can even sometimes be directly removed. In pelvic disorders a lasting result of this treatment can be obtained only by a gradually increasing and persevering use of this apparatus, in combination with generally strengthening movements.

The apparatus E 8 can be employed also to exercise the abdominal muscles, when the purpose is to avoid stronger pressure within the abdominal cavity. The balance weight of the movable plane is moved so much further that the weight of the patient does not press it down, and the position of the movable plane is raised so that when the patient is lying on it, as indicated above, his abdomen is free and not touching the fixed plane. The apparatus is not set in motion, but the

patient tries to bend the lumbar region upwards by contraction of the abdominal muscles. This movement is repeated from 2 to 20 times.

The apparatus is further used for straightening lateral curvatures of the spine and to increase the mobility of the latter. Then the prescription indicates:

Position on the right or left side. The movable plane is in an horizontal position and the patient places himself on the indicated side with his hip near the free (movable) edge of the posterior plane and with his shoulder and side resting on the fixed plane. Before the apparatus is set in motion, the number for the crank-pin and that for the connecting-rod must be adjusted to the same figure.

F. Vibration.

F 1.

Vibration of different parts of the body.

The parts of the apparatus which are set vibrating, in order to impart vibration to the different parts of the body, are partly a cushioned cross-board, partly a vertical axle with a movable graduated transverse-bar at the outer end of which the accessory appliances (plates, balls and handles of various shapes and sizes) are to be fastened. The cross-board shakes most at the side where the driving-belt is attached, and least at the opposite end (the zero point). The vibrations conveyed by the vertical axle are stronger according as the small graduated transverse bar with the accessory appliances, is moved forward, that is, proportionally as the latter are removed from the vertical axle.

The vibratory operations most frequently used are:

By means of the cross-board.

Foot-vibration. The patient seats himself on an ordinary chair and lays his legs on the cross-board in such a way that his heels reach beyond it. It is not permitted to place the feet on the cushion, while bending the knees, as this would injure the mechanism of the apparatus. The leg-muscles should be relaxed during the movement.

Vibration of perineal region. The patient seats himself astride on the cross-board, near the zero end and with the back turned to it. The vibratory movement is conveyed to the whole body, but most strongly to the floor of the pelvis and the organs near it.

By means of the vertical axle and accessory appliances, consisting of

1. a larger round cushion.
2. a smaller do

Shoulder vibration. Sitting. The cushion is made to act on the front, side and back of the shoulder-joint, that is on the entire deltoid muscle.

Shoulder-blade vibration. Sitting. The cushion is applied to one shoulder-blade at a time.

Back-vibration. The movement can be taken standing or sitting, and the cushion is placed as high as between the shoulder-blades.

Vibration of the lumbar region. Sitting or standing. The cushion must be applied to the height of the upper lumbar vertebrae.

Sacrum-vibration. Sitting or standing. The cushion should be applied to the height of the loins.

Hip-vibration. The point of application of the cushion is between the crest of the hip-bone and the trochanter, and behind the latter on the large gluteal muscle.

Chest-vibration. The cushion is placed on the middle of the sternum, as well as between the latter and the shoulder.

Epigastrium-vibration. Standing. The cushion is applied exactly to the spot indicated.

Vibration of the transverse colon. Standing. The cushion is placed below the epigastrium or below a line which would connect the front ends of the tenth ribs, and above the umbilicus. The movement must

act from the right to the left, that is from the region of the liver to that of the spleen. Therefore the patient first turns to the left in order to place the cushion on his right side and makes it pass to the left by turning slowly round to the right. He draws back when the cushion has reached the left side, in order to repeat the movement in the same manner several times for about one minute.

Vibration of the small intestine. Standing. The cushion is placed exactly on the umbilicus.

Vibration of the hypogastric region, right or left. Standing. The cushion is placed close above the right os pubis (the cæcum) or the left (S. romanum of the colon descendens).

Lateral knee-vibration. Standing. The cushion is applied to the inner and the outer side of the knee-joint.

Vibration of the bend of the knee. Standing. The cushion is placed in the bend of the knee.

N. B. The larger or the smaller cushion is employed, according as a more or less extensive surface is to be acted on.

3. *An iron with a small oval vertical plate.*

This is employed when the purpose is to reach the depths of a muscle, or deeply imbedded nerves.

Hip-nerve-vibration. Standing. The small felt-and-leather-covered plate is pressed into the bed of muscles between the large trochanter and the os coccyx.

4. *A padded iron of 2,5 cms' width, bent like a crutch, with the convexity outwards.*

This crutch is formed as the arch of a circle and when the horizontal transverse-bar is adjusted at No 5, the centre of the arch coincides with the central line of the vertical axle. The movement therefore acts with equal force, wherever the arch is touched.

Neck-vibration. The iron is placed in the hollow of the neck, higher or lower, and also on its side, wherever a sensitive spot is found (muscle infiltration).

Forehead-vibration. The iron is placed on the forehead above the eye-brows.

5. *An india-rubber ball.*

Vibration of the temples, ears, nose and throat. This ball is used when a smaller sensitive spot, especially about the head, is to be treated. In *ear-vibration* the ball is placed against the ear-muscles. In *nose-vibration* it is made to act first on one and then on the other side of the nose.

In *throat-vibration* it should be placed on both sides of the throat against the angle of the lower jaw.

6. *A small fork-shaped cushioned iron.*

Larynx-vibration. The iron clasps round the larynx.

7. *A bent iron of 3,5 cms' width and with the concavity turned outward.*

Vibration running along the upper arm. The iron is applied to the middle of the upper arm. By raising and lowering the shoulder the upper arm is moved up and down in the iron-bow.

Vibration running along the thigh. The iron is adjusted to half the height of the thigh, of which the different sides are pressed into the iron and made to move up and down along it by bending the knee-joint.

Knee-vibration. The iron is placed just above and below the knee-pan.

Calf-vibration. The iron clasps round the thickest part of the calf; here also the leg must be to some extent raised and lowered.

8. *A bent iron of 3,5 cms' width with the concavity turned upward or downward.*

Vibration of the top of the shoulder. The iron rests on the shoulder.

Vibration of the supported arm. The patient seats himself in front of the apparatus a little on one side, resting the sideways extended arm on a rod. The bent iron acts on the upper or lower side of the arm, on such spots for instance as suffer from muscle-infiltration.

9. *An iron with a button-shaped knob turned downward.*

This iron is made use of in order to reach farther into the muscles as, for instance, in shoulder-top vibration, or when certain spots on the forearms or hands are to be treated.

10. *An iron, furnished with two horizontal handles.*

This piece serves to set the whole arm in vibration; but it depends on the direction and position of the arm, whether the vibration acts on the whole arm or more especially on a certain part of it. Only those muscles are contracted by means of which the hands clasp the handles, the others remain relaxed.

Vibration of the raised arm right or left (sitting). The patient is so placed that he turns the side in question towards the apparatus and grasps one of the handles which is adjusted to a corresponding height, while his arm is extended sideways and half raised. The movement exercises a powerful effect on the entire arm, as well as on the shoulder-joint and the shoulder-blade.

Arm-vibration. The patient is sitting with his face turned towards the apparatus; he grasps the handles with both hands so that his arms are in an horizontal position. Effect on the whole arm.

Forearm-vibration. The patient stands as before, the handles are lowered so that only the forearms are horizontal. Effect chiefly on the forearm.

Hand-vibration. Position as before. The handles are placed so low that the forearms also slant down-

ward when the hands lightly clasp the handles. Effect chiefly on the hands.

A vibrating solid object exercises, when it comes in contact with the soft tissues of the body, a quickly alternating tension and relaxation of the latter. This accelerates the circulation in capillaries and lymphatics; the reabsorption increases, and the dispersion of infiltrations in muscles and tendinous tissues is promoted.

The mechanical stimulus of the vibration causes, directly, or by reflex action, a contraction of the smooth muscle fibres, which manifests itself in various manners. A *vibration of the os sacrum* causes such vigorous contractions in the full rectum or bladder that the sphincters of these organs must powerfully contract to prevent evacuation. Expectoration is facilitated by contraction of the bronchiæ in *back-or larynx-vibration*. Sensitive persons have a sensation of coldness in their feet during *foot-vibration*, upon which increased warmth soon follows however, corresponding to the subsequent relaxation of the vascular muscles.

The mechanical stimulus of the vibration has further a sedative effect, which possibly is explained by its immediate effect on the disposition and mutual action of the nerve molecules.

A vibration lasting about two minutes, applied to a painful spot, is often sufficient to relieve pain, at first for a short time, but also on repeated application for more length of time.

The stimulating influence of vibratory operations on enervated muscles is no doubt in connexion with their sedative effect and with the accelerated circulation. A *foot-vibration* after much walking, a *back-vibration* after much sitting, and a *larynx-vibration* after much talking or singing will invariably cause a pleasant and beneficial effect.

F 2.

Vibration of the whole body (saddle-sitting).

The object of this apparatus is to produce a vibration of the whole body as in riding.

A wooden frame shaped like a horse's body, with man's-saddle or side-saddle, is set in vibratory motion. It is advantageous to have two side-saddles, one for the right and one for the left side, that this refreshing movement may be used in scoliosis. A saddle adjustable for right or left side could not be used for this purpose. The apparatus makes about 180 vibrations a minute. Their force is regulated by means of a screw applied on the fly-wheel. The movement is to be continued for 2 or 3 minutes.

Saddle-sitting vibration acts stimulatingly on the sympathetic system of nerves. In persons unused to riding the arterial system contracts more or less. This can easily be proved by noting the pulse curve immediately before and after the vibration. In persons accustomed to riding this reaction fails to appear.

For persons with feeble cardiac action who are unused to riding, great caution must be observed with regard to this movement, since by the contraction of the arterial channels the action of the heart is increased. If palpitation or giddiness come on, this movement is to be entirely omitted.

Experience has repeatedly taught that saddle-sitting vibration acts as a stimulative on a torpid intestinal canal.

In ruptures, catarrh of the bladder or hemorrhoids the movement should be avoided, or taken very slightly (No. 2—3 or at most 4).

G. Percussion.

The following apparatus have 2—4 elastic hammers of steel and India rubber, or leather-covered steel-springs, which by motor power are set in a rapid oscillating movement. Two sets of hammers of different strength belong to each apparatus. The weaker hammers are used for more sensitive spots, as for instance between the shoulders, for the chest, the epigastrium and the hypogastrium, where strong percussions are never to be applied. The strength of the percussion does not depend only on the hardness or softness of the hammers, but also on the strength with which the patient presses the part which is to be treated, against these hammers.

The percussions have about the same effect as the vibrations, though more superficially and locally, and exercise more irritation on the softer parts, especially when, as a thin coating, they cover a bone. On fresh infiltrations therefore, no percussions, but light vibrations should rather be employed.

G 1.

Trunk- and arm-percussion (I size).

This apparatus is furnished with 4 hammers and destined for percussion of larger surfaces of the trunk. The raising and lowering of the hammers is executed by the apparatus itself; one has only to manage a

belt-shifter to obtain this. Placing it in a middle position one can stop the apparatus at any height wanted.

The apparatus can be used in different ways, as for instance:

Percussion along the back. The patient is seated with his back turned to the hammers and with his right hand moves the belt-shifter of the elevation-mechanism, so that the hammers run up and down 2 or 3 times. At the beginning of the movement the patient ought not to press his back close to the hammers, but should do so gradually, until the percussion becomes sufficiently strong.

Percussion between the shoulder-blades. The hammers must be moved up and down 10—15 cm. so that the percussion acts on the space between the two shoulder-blades.

Percussion along the lumbar region. The hammers are to be moved up and down along the lumbar region.

Percussion of the lumbar region (crosswise). As before, with the difference that the patient moves to the right and left, so that the percussion acts on the sides.

Percussion of sacrum, hip and shoulder acts on the parts named.

Percussion of the whole abdomen. The patient stands with the abdomen turned to the hammers, and, while these go up and down, he moves alternately to the right and left, so that the percussion is distributed all over the abdomen.

Percussion of abdomen, to the right is taken only on the right side of the abdomen between the right groin and the edge of the ribs. (Colon ascendens.)

Percussion of abdomen, to the left is taken only on the left side of the abdomen, between the left groin and the edge of the ribs. (Colon descendens.)

Stomach-percussion. The hammers act on the stomach *i. e.* on the triangle between the lower end of the breast-bone and the connecting line of the free edges of the tenth rib on each side.

Percussion of the transverse colon. The apparatus is adjusted so high that the hammers exercise their effect on the space between the front ends of the tenth ribs and the umbilicus. The patient turns himself so that the percussio passes from right to left, from the region of the liver to that of the spleen. (Colon transversum.)

G 3.

Leg-percussion.

The apparatus is furnished with 2 hammers and is intended for percussion of the legs.

By means of a handle the patient can himself move the hammers of this apparatus up and down and make it work on affected spots. The apparatus is used:

in percussion running along the thigh, for all the muscles of the thigh, for those of the anterior as well as of the posterior side, if »front» or »back» is not specially prescribed.

in percussion running along the leg for all the muscles of back and outer side of the leg.

(On the front side with its hard bony surface immediately beneath the skin no percussion should be undertaken.)

in percussion of the calf of the leg which is applied on the calves. Percussions should never be applied to places where varicose veins exist.

G 4.

Trunk- and arm-percussion (II size).

With this apparatus which is furnished with 2 hammers all the movements indicated under G 1 can

be taken, though not to so great extent; but the patient can help himself here, as, by means of a handle, he is able to move the hammers up and down and apply them particularly to such places as need special treatment (as for instance in muscle-infiltration).

G 5.

Head-percussion.

The patient places himself before the apparatus and has the seat screwed so high that the hammer can work on the head. He bends it forward, backward and sideways so that the hammers may work on as large a surface as possible. The height of the seat must be so adjusted, that the effect of the hammers is felt more strongly with the back kept straight, and more feebly when it is bent. By way of experiment one should always take a slight percussion before trying one of greater intensity, and immediately cease when giddiness is felt.

Head-percussion promotes the circulation and affluence of humours to the softer coatings of the brain-pan, for which reason it can be used advantageously in local rheumatic infiltrations. The head is set in a slight vibration which undoubtedly causes a momentary contraction of the brain-vessels with ensuing dilatation, thus effecting increased affluence of blood, whereupon the original state is restored. This fluctuation in the circulation, as well as the immediate effect of the vibration on the brain-molecules, is probably the cause of the frequently observed effect, peculiar to this movement, upon head-ache and sleeplessness.

H. Kneading.

H 1.

Abdomen-kneading.

The apparatus has a movable, cushioned plane raised in the middle, and is set in a forward and backward motion, while six wheels in the opening of the elevated part of the plane move alternately up and down. By turning a regulating wheel a mechanism is set in motion which increases or diminishes the movement of the wheels, as is shown by an index in connection with it, marking a higher or lower figure. This figure is indicated on the prescription. The backward and forward movement of the plane can also be moderated.

The patient places himself with the abdomen on the elevated part of the plane, so that it is exactly above the opening through which the kneading wheels work. The elbows are supported on the cushion in front of the elevated part; the abdominal muscles should be relaxed.

The movement should last 2 minutes.

The circulation of blood and lymph is accelerated, as well in the abdominal muscles as in the intestines, and the contractions of the latter stimulated.

J. Friction.

J 1.

Arm-friction.

The arm-friction is accomplished by two pair of straps running up and down and kept stretched by means of a lever furnished with a weight. The figures on the prescription refer to the weight on the graduated lever. The seat is screwed so high that the arm of the patient, stretched out between the rubbing straps, is horizontal after the hand has grasped the movable handle. To relax the straps and facilitate the insertion and withdrawal of the arms, the patient presses with his free hand the handle in front of the seat.

The arm is twisted and moved backward and forward while it is being rubbed by the straps.

The movement lasts 1 minute for each arm.

Rubbing the arms and rolling their muscles powerfully, draws blood to the arms and warms them.

The movement disperses muscle-infiltration.

J 2 b.

Finger-friction.

J2 b is an apparatus for massage which performs friction exactly to the desired extent and with the force required, in such a way that during pressure it

strokes forward, and goes back with cessation of pressure.

The friction is effected by means of a couple of steel-springs which, at their free ends are furnished with padding. When the apparatus is in motion the spring-ends clasp and stroke the fingers from the tips upwards.

The padding is covered with a fresh piece of wash-leather for each patient. This leather is fastened with an india-rubber-ring and greased with vaseline. To do this more easily the springs can be detached from the apparatus by means of a key.

The mechanism is enclosed in a wooden case.

Five striated brass buttons serve for the following purposes:

1. *The two side buttons* one at the right the other at the left side of the case serve for adjusting the springs at a suitable distance from each other. If the patient turns the knob away from him, the springs approach each other and *vice versa*.

2. *The right (upper) button on the front side of the case* is turned, according to the directions on the engraved brass plate, to set the apparatus in motion or to stop it.

3. *The left (lower) button on the front of the case* serves to determine the extent of the friction. The brass plate gives due directions.

4. *The button on the front edge of the table-plate* regulates (also according to the directions on the engraved brass plate) the strength of the pressure, that is. how far the springs are to approach each other when they move forward.

All these buttons can be manipulated and brought into action, while the apparatus is in motion.

It is only fair that for the use of this apparatus an extra fee should be paid, since, in distinction from the other gymnastic apparatus it requires special

attendance and causes extra expense for fresh wash-leather, vaseline and towels. If this massage is given manually, it is expensive, and for this reason the treatment is either not employed at all, or not long enough to effect real improvement. For this purpose the apparatus is so arranged that it cannot be set in motion unless a metal counter of the proper size be put in through a slit in the upper part of the wooden case. A number of such counters belong to the apparatus and can be bought by the patient at a fixed price. After 120 strokings the apparatus stops, and can be set in motion only when another counter has been thrown in. During the 120 strokings the apparatus can at pleasure be stopped and set in motion again.

Just beneath the springs there is an iron rest, fastened by means of a clam-screw where the fingers are placed during the massage. It can be removed, when, as for instance in stroking the metacarpal bone of the thumb, it is in the way.

There further belongs to the apparatus an iron stand with an adjustable cushion for supporting the forearm.

If the apparatus is to be used, the patient places himself so that the hand which is to be treated can be comfortably held before the springs and rests the forearm on the cushion of the stand. After the finger and the padding have been vaselined, and the former has been placed between the springs, these are adjusted so that the padding presses the finger tightly. Then the finger is removed and the apparatus is made to execute some strokings, to see if their length is suitable. If the padded ends of the springs come to closely together, by which the stroking would become too strong and painful, the button on the front edge is screwed to the left, till the distance between the springs is increased. Then the finger is again placed between

the springs and the necessary alterations undertaken, while the massage is going on.

Finger-friction is used when the fingers, their joints or tendon-sheaths are swollen, whether it be by rheumatic or traumatic causes. In cases of frost-bite it is also serviceable.

In consequence of an inevitable degree of strength in the friction, pain cannot be wholly avoided; but it can be very much mitigated, if one begins with a slight pressure, and only gradually increases it.

J 3.

Leg-friction.

Leg-friction is accomplished by means of two arms which move backwards and forwards and are provided with smooth or ribbed cushions for friction. By a regulating wheel these are so adjusted that they act on a certain part of the leg, or they are moved up and down so that they rub along its entire length.

By a lever furnished with weights the friction-cushions are approached to each other in order to afford the required pressure.

The patient places himself before the apparatus, puts the leg which is to be rubbed between the cushioned arms, and by the regulating wheel adjusts these to the height of the spot which is to be treated, or makes them move up and down.

The movement lasts 1—3 minutes for each leg.

The most common operations executed with this apparatus are:

Leg-friction. The cushioned arms are adjusted to their lowest position, the leg is placed between them, and the regulating wheel slowly turned so that the cushioned arms moving upward along the leg, act on its whole length.

The leg is constantly turned; it is removed when the cushioned arms move downward.

Thigh-friction. Rubbing the thigh from the knee upward.

Knee-friction. While rubbing the outer and inner side of the knee, the cushions are raised or lowered 10—12 cm.; while rubbing the front or back of the knee the cushions are placed first above and then below the knee-pan.

Leg-friction from the ankles up to the knee.

Heel-friction. The patient stands with one foot on a footstool, and pushes the heel of the other foot between the cushions by bending the front part of the foot upwards. (The shoes must of course be taken off.)

Effect: friction of the skin and rolling of the muscles. Promotes flow of blood to the legs and warms them. Acts discussively on existing infiltrations in the muscles and the neighbourhood of the knee-joint. If these are fresh, only smooth cushions should be applied. For patients with varicose veins leg-friction is contra-indicated.

J 4.

Foot-friction.

The patient seats himself on the wheeled chair, takes off his shoes, places the lower part of his legs or the heels, on the cushion, pressing the soles against the ribbed wheel. To protect the stockings a piece of wash-leather attached to the cushion is laid over the wheel. As soon as this is set in motion the soles are rubbed, and the movement is continued as long as necessary, 1—3 minutes.

The tickling which in the beginning troubles some persons, sometimes disappears on stronger pressure,

and if not, a thin cushion must be placed between the feet and the wheel.

The friction draws the blood to the feet and warms them. In very sensitive persons the irritation of the nerves of the skin causes such a contraction of the vessels that the feet feel cold while they are being rubbed. If this chilliness does not disappear immediately after the cessation of the friction and is not succeeded by an agreeable sensation of warmth, it is better, for the time being, to substitute for it some active exercises such as B11 and B12.

Hand-friction can also be accomplished with this apparatus, by placing the hands on the ribbed wheel. And with this same wheel heel-friction can also be effected; the shoes are taken off and the heel and the sides of the ankle-joint are made to rub against the ribs and padded edges of the wheel. In rheumatic swelling at the insertion of the tendo-Achillis on the heel-bone, this movement is very effective. The back of the foot can also be rubbed on the wheel.

On the same axle which carries the large wheel there is also room for a smaller one (which can be constructed by request) and with which, among other joints, the knee-joint and the bend of the knee can be rubbed.

J 5.

Back-friction.

By means of two padded wheels which exercise a certain pressure while rolling up and down on each side of the spinal column, a progressive stroking or friction of the soft part of the back is accomplished.

The prescription indicates two numbers. The *first* refers to the position of the movable weight on the graduated lever which effects the pressure of the wheels

on the back; the *second* determines the extent of the forward and backward movement of the wheeled reclining-chair on which depends whether the friction is to act along the whole back or only on its inferior part. These figures correspond to the scale of the crank which is graduated from 12 to 36 centimeter. The extent of the friction must be determined according to the length of the back, and its inferior part (the os sacrum) is always taken as starting-point. For this purpose one must be able to lengthen or shorten the connecting-rod even so much that its movable socket *A* is adjusted to the same degree which is determined for the crank. The patient places himself on the chair as high as possible and rests his head and back against the strongly inclined back-support.

When the apparatus is set in motion, the padded wheels which have been kept down by a closing mechanism, are set free when they reach the lumbar region and then rub the back. *When the movement is to cease, the patient should, before rising, press down the closing mechanism with his left hand*, that the heavily weighted levers may be fastened and not fall down, which, besides damaging the apparatus, causes a disturbing noise.

The movement excites the circulation of blood and lymph in the softer parts of the back and acts as a sedative on the sensory nerves of the skin.

J 6.

Circular abdomen-friction.

The apparatus consists of two stands with screws, one stand carrying a back-support, and the other the mechanism for the two rollers or wheels which are to work on the abdomen. The patient places himself

between the two stands, and leans the inferior part of his back against the angular back-support, of which the height is to be so adjusted that the patient is half-sitting on it with his legs straight and his toes placed on the foot of the stand before him. The mechanism is raised or lowered so that its axle comes straight before the umbilicus. The swinging-bar is placed vertically so that the lower wheel touches exactly above the symphysis, while the other wheel is similarly adjusted, or placed one degree higher.

By turning the regulating wheel to the right the trunk is moved forwards by means of the back-support, until the abdomen is tightly pressed against the wheels when the apparatus is set in motion. With the aid of the same regulating wheel as well as with that of the lever of the closing mechanism to the left, the pressure to be exercised by the wheels on the abdomen can be so moderated that it presses deeply enough without inflicting pain. The mechanism for raising and lowering the wheels can also be set in motion in case some change in the wheel-stand should be required. If the pressure of the wheels on the abdomen is to be quickly suspended the lever of the closing mechanism, to the left, is raised, while by turning the regulating wheel, on the right, the back-support is moved backward.

The movement accelerates the circulation of blood and lymph in the walls of the abdomen, as well as in the intestines and causes contraction of the intestinal muscles.

The apparatus acts more especially on the colon, as the wheels approximately follow the direction of the latter. As they also go in the same direction as the contents of the intestines, the emptying of the latter is vigorously promoted.

IV. Orthpædic apparatus.

K. Passive redressments.

These apparatus are intended to exercise corrective influence on abnormal curvatures of the spinal column by suitably applied pressure, extending contracted muscles and ligaments which fix the vertebræ in an oblique or rotated position to each other. This corrective pressure further relieves that part of the disc of intervertebral cartilage which is in the concavity of the curvature, while the part which is in the convexity is exposed to stronger pressure.

In some apparatus the correcting influence is increased by the patient's being in a suspended or reclining position, by which the pressure on the spine ceases, or the latter is actually stretched by part of weight of the body.

K 1.

Lateral suspension (reclining).

The apparatus has a movable plane which can be adjusted at different angles to the horizontal. At the fixed end of the plane there is a cushioned cross-beam, and on the other side of the latter a movable ladder for the hands to grasp. Beneath the cross-beam there is a second, non-adjustable ladder. Between the cross-

beam and the movable ladder, there is a saddle-girth to support the head of the patient. The movable plane has a centimeter-gradation of which zero coincides with the back edge of the cushioned cross-beam.

The plane is adjusted horizontally. The patient places himself on it so, that the convexity of the spinal curvature rests on the cross-beam and the head on the saddle-girth; with the arm of the side turned upwards he grasps the movable ladder which is adjusted so as to cause the arm to be fully extended. With the other arm he takes hold of the fixed ladder under the cross-beam. The position of the trunk, however, should not be purely lateral, but somewhat turned upward, so that the pressure of the cross-beam acts in the direction of the right or left diagonal of the thorax, according as the patient is lying on his right or left side. And to correspond with this position, the patient does not grasp the middle of the ladders, but puts the upward stretched hand more behind him, and the hand stretched downward more in front.

If the upper curvature lies high (dorso-cervical), it is of importance that the shoulders should be as firmly fixed as possible. For this purpose the movable ladder is grasped with both hands by the top and bottom rounds, and the lower arm held quite stretched. By this the shoulder which is usually drawn up is lowered, and the other is raised, and thus the corrective influence of the lateral pressure on the spinal curvature is increased.

Those who have at their disposal the writer's trunk-measuring-apparatus and have obtained by means of it a vertical sectional diagram in the frontal plane, can at once read off from this at what distance from the soles the lateral pressure must be applied, and this is indicated on the prescription. Then the patient has only so to place himself on the plane that the soles of his feet are on a level with the indicated number

of centimeters on the scale of the plane, and one may then be perfectly sure that the pressure is always applied on the right spot.

When the patient has thus assumed the prescribed position, the handle at the free end of the plane is grasped, and raised a little; one of the attendants moves the pin of the iron-bow to the hole indicated on the prescription, and the plane is slowly lowered until the pin touches the check-board.

The patient remains in this position 3—5 minutes or longer; on loosing his hold of the ladders, he glides down and stands on the floor. It is better to let the patient use the apparatus 5 minutes twice during the hour of exercise, than once for 10 minutes.

The use of the apparatus is indicated on the prescription, in the following manner for instance:

K 1, right, 105, 30°, indicating on which side the patient should be placed, 105 the position of the soles of the feet on the plane, and 30° the inclination to be given to the latter.

The apparatus is used for exercising a corrective influence on the lateral curvature in a total C-shaped, or on the dorsal curvature, in an S-shaped scoliosis.

K 2.

Lateral pressure (lying).

This apparatus consists of a frame resting on two trestles. The one half of the frame carries a cushioned plane, that can be inclined at an angle of 15° or 20° to the horizontal plane and is furnished with a scale indicating in centimeters the distance from the fixed end of the plane. The other half is occupied by three movable cushioned supports, which can be placed as well at different distances from the fixed end as at

different heights above it, in accordance with centimeter-gradations on the apparatus. The one or two supports nearest the plane, the *lateral pressure cushions*, are to act against curvature of the spine, the other, the *head-cushion* is intended to support the head. The latter can be adjusted horizontally, or as far as an angle of 20° .

The patient lies down on the cushioned plane on the side towards which the convexity of the lumbar curvature is turned, so that the crest of the hip-bone coincides with the fixed edge of the plane. By means of the trunk-measuring apparatus it is easy to ascertain the distance between the soles of the feet and the crest of the hip-bone, and this distance indicates the point where the soles of the feet must be placed on the cushioned plane. The first *lateral pressure cushion* (Lpc) is so far removed from the edge, that it presses against the greatest deviation of the lumbar curvature. The second is used alone or together with the first in long total curvatures, or to support the upper part of the chest when the muscles of the neck would improperly be strained. Its position is also determined by means of the trunk-measuring-diagram. The *head-cushion* (Hc) is adjusted at a suitable distance, its height and inclination being determined by the character of the upper curvature or curvatures, and by the position of the head. The trunk is turned with the abdomen slightly upwards, so that the lateral pressure cushion presses diagonally; the legs are kept somewhat bent, as then the patient rests more firmly on the plane. When the position of the patient is thus settled, the free end of the cushioned plane is raised, if this movement be prescribed by the word *inclination*, and it is fixed by a mechanism under the plane at an angle of 15° , or, usually, 20° .

The patient remains in this position for 5 minutes. On the prescription the use of this apparatus is indicated in the following way, *e. g.*:

K 2, left, 102, $\frac{d:10}{h:12}, \frac{0}{0}$ or

K 2, left, 102, $\frac{d:10}{h:12}, \frac{d:20}{h:10}$

which means: the patient lies on the left side, the soles of the feet 102 cm. from the fixed end of the cushioned plane and the first Lpc. at the distance of 10 cm. and a height of 12, either alone or together with the second at 20 cm. distance and 10 cm. height. The position of the head-cushion is usually not indicated in the prescription.

The apparatus is employed in order to exercise corrective influence especially on lumbar curvatures. It is more suitable in these curvatures than K 1, and that for the following reasons: with K 1, one does not succeed in correcting curvatures situated lower down and it is often very difficult to correct, by mere lateral pressure, the oblique position of the lower lumbar vertebræ to the pelvis. For this purpose it is necessary to be able to rotate the pelvis on its sagittal axis, while the spinal column is prevented from following the movement, The former is accomplished by means of the rotatory plane on which rest the pelvis and the lower extremities which fix the pelvis; the latter object is accomplished by the lateral pressure cushion which presses the spine in the opposite direction to that in which the pelvis is rotated. In lumbar curvatures of long standing, even when the lateral deviation is not very considerable, the inclined position of the spine in relation to the pelvis can be so firmly fixed by partial absorption of the intervertebral cartilage and by the retraction of muscles and ligaments, that gymnastic movements, often most effective in lumbar curvatures, remain without the slightest effect, while by application of K 2, or some similar apparatus, the mobility of the lumbar vertebræ may be restored.

Many patients cannot endure the raised position because of congestion to the head. In such a case and if the inclined position is necessary, the trestle, supporting the foot-end of the frame, must be taken away and this end be laid down on the floor.

In cases of low dorsal curvature with only a slight compensatory lumbosacral curvature, the apparatus must not be used, as it would make the condition worse.

K 3.

Chest-rotation (lying).

This apparatus consists of an inclined plane with a movable foot-board, of a mechanism working through an opening in the upper part of the plane, as well as of two adjustable shoulder-crutches which clasp the arms of the patient and prevent his slipping down on the plane, when the foot-board is removed, and finally, of a CHARCOT head-holder.

The above mentioned mechanism rotates the thorax by means of two cushions, of which the one, the *back-cushion* (*Bc*) is applied to that part of the back where the projection of the ribs is to be found, and the other, the *chest-cushion* (*Cc*) to the corresponding projection on the opposite (front) side of the thorax.

The *back-cushion*, by means of a double hinge, is attached to the *cushion-holder*, a flat iron, provided with holes marked with numbers at a distance of 1 cm. from each other. This cushion-holder is always kept in a vertical position by two parallel fork-shaped levers, turning upon two axles in the vertical middle plane of the apparatus. These levers grasp the cushion-holder between their shanks and, by means of a pin it is adjusted as well at a due distance from the middle line of the plane as at a proper height above its

level. The holes of the levers are marked with letters: *A* means 6, *B*—8, *C*—10, *D*—12, *E*—14, centimeters from the rotation-axis. The holes in the cushion-holder also have numbers, expressing in centimeters the distance of the surface of the cushion above the inclined plane in the horizontal position of the levers.

If the back-cushion (*i. e.* its central point) is to operate for instance at 8 centimeters' distance from the middle line, the pins are inserted in the holes marked *B*. If the height of the cushion above the plane is to be further increased 5 cm., the pin in the hole *B* of the upper lever must also pass through the hole 5 of the cushion-holder. As the rotation-axles are situated at a distance of 10 cm. from each other, and the levers always remain parallel, it is necessary, in the example given, to pass the lower pin through the hole *B* of the lower lever and the hole 15 of the cushion-holder.

The application of the *chest-cushion* requires more particular arrangements still. The ends of the two parallel levers are united by two vertical rods with their ends bent in right angles and pierced by rectangular holes in which the vertical cushion-holder is lodged and can be fixed at a suitable height. The gradation on the holder indicates the height of the chest-cushion above the inclined plane, when the levers are horizontal. The *vertical* cushion-holder is at the top furnished with a socket, through which the *horizontal* cushion-holder passes. This latter can be fixed by means of a screw so that the chest-cushion is made to act at a suitable distance from the middle-line of the apparatus. The vertical holder of the chest-cushion is much longer than that of the back-cushion, as the height of the former above the plane is much greater than that of the latter, equalling, that is, the height of the back-cushion, plus the sagittal diameter of the chest. But generally the height must be calculated a little higher, since the pressure of the chest-cushion must be less

strong than that of the back-cushion. When therefore the height of the latter is determined to 5 cm. and the sagittal chest-diameter amounts to 17 cm., 3 cm. are added to lessen the pressure on the chest; then the height of the chest-cushion becomes 25 cm. The pin which fixes the vertical cushion-holder must then be put in the hole which is marked by the corresponding number.

The upper rotation-axle is fixed and its levers can turn freely on it, but the lower one turns on fixed bearings and its levers are fixed on the axle. This axle carries also a particular lever which, being moved upwards, strikes on both sides at an angle of 15° to the horizontal plane, against a pin stuck in a round plate attached to the same axle, and turns the axle from right to left when the lever is directed towards the right side of the plane, and from left to right when it is directed towards the left side. In this manner the lever acts on the whole system.

The pressure exercised by the cushions on the thorax is conveyed by this lever and is brought about in the following manner: on both sides, below the outer edge of the plane there is a pulley with a cord passing above it, and at each end of this cord there is a hook. One of the hooks is attached to the free end of the lever, the other carries a weight of 2,5—10 kilogr. The lever must always be moved upward and weighted on the side where the back-cushion is placed.

The use of this apparatus is made considerably easier if one has a transverse sectional diagram of the thorax at the height of the greatest projection of the back; then it is quite easy to determine in advance the application of the apparatus. To determine *the place of the foot-board* one must also know the height of the greatest deviation above the floor, when the patient is standing. This measure, expressed in centimeters is subtracted from 135: the remainder indicates in which of the holes at the lower end of the plane

the pins of the foot-board should be inserted. Its *lowest* position is 135 cm. from the central point of the back-cushion.

The distance of the back-cushion from the middle line of the apparatus is calculated so that it presses on the middle of the rib-projection. According to the breadth of the patient's chest, the cushion-holder is fastened in the hole *A, B, C, D* or *E*. The outer holes (*D* or *E*) are used when it is required that the apparatus should not only effect rotation, but also exercise pressure in a diagonal direction. But it is difficult to determine the proper place of the cushion without a transverse sectional diagram of the thorax.

The height of the back-cushion ought, in most cases, to be so determined that it is raised a few centimeters above the plane, when the levers are horizontal. The pressure on the rib-projection not only rotates, but also raises the thorax. The elevation is certainly counteracted by the pressure of the chest-cushion, but only to a certain extent, as the chest-cushion may never press so tightly as the back-cushion. Therefore, if the patient has a light, elastic trunk, easily yielding to the pressure of the back-cushion, the levers may come in such an oblique position that they would be ineffective, a case which happens when they are at an angle of 30° to the horizontal. To prevent this, the back-cushion is adjusted a few centimeters above the plane, whereby the levers obtain a greater range than 30° .

The height of the chest-cushion above the plane is calculated as indicated above. The number of centimeters thus obtained indicates in which hole of the cushion-holder the pin is to be inserted. The *distance of the chest-cushion from the middle line* is regulated by pushing the horizontal holder in or out in its socket. The number of the line which coincides with the outer edge of the socket indicates in centimeters the distance

of the central point of the chest-cushion from the middle line, and this distance is determined so that the cushion presses against the highest projection of the ribs, or somewhat outward of it, when a compression of the thorax in a diagonal direction is intended.

On the prescription the arrangement of the apparatus is, indicated thus, *c. g.*:

K 3, Fb, 24. — Bc. r. B 7. Cc. l. 17 (12) Sh. c. 144. Wght 5.

i. e. the foot-board is placed in the hole 24. *Back-cushion right*, with the upper pin in the *hole B* of the lever and in the *hole 7* of the cushion-holder. *Chest-cushion*: left, with the pin in the hole 17 of the vertical cushion-holder, the horizontal holder with the line 12 at the outer edge of the socket. *Shoulder-crutches*: 144 cm. high. *Weight*: 5 kilogr. The height of the crutches is generally ascertained by the medical attendant and noted on the prescription; as mentioned above, these should be so adjusted that the patient does not slip down, that is, does not alter his position when the foot-board is removed.

After the apparatus has been thus arranged the patient lies down on the plane with his feet against the foot-board, places his arms in the crutches, which are so adjusted that he retains his position when the foot-board is removed. One should be careful that the cushions are properly placed and that, after applying the weights, the pressure is not too strong and that it is felt most at the back. Then the foot-board is removed, and the patient remains in this position 5, 10, 15 or 20 minutes, according as he grows accustomed to the effect of the apparatus. While reclining, *he must often breathe deeply* that the side of the thorax which is not under pressure may duly expand. A vigorous inspiration is promoted by a forced double expiration (OERTEL).

The object of the apparatus is to counteract, lessen or remove that most dangerous symptom of scoliosis, and the most difficult to overcome: *Rotation of the dorsal vertebræ and torsion of the thorax*. Its chief application is to correct dorsal curvatures, but can also with advantage be used against lumbar curvatures, when an incipient rotation is noticed and then the back-cushion only is applied. The chest-cushion is of no importance in the latter case, as there are no ribs to be acted on and it is therefore placed very high, or only used as a side-support. In dorsal curvatures, on the contrary, it is of great use, not only by pressing backward the ribs which by the rotation of the vertebræ have been pushed forward, and thus contributing to their correction, but also by checking the respiratory movements of the prominent half of the chest, so that the sunk side is more completely filled by the inspirations.

It is easy to ascertain the powerful and appropriate effect of the apparatus by watching the change of shape in the thorax, while under its influence. It is natural, that alone, without simultaneous use of active gymnastic movements (trunk-rotation, pelvis-rotation and arm-movements which expand the chest) it cannot cause any real improvement in the shape of the thorax. That patience and consistent application, proportional to the duration and development of the scoliosis, are required, follows from the undisputable truth that nobody can make a scoliotic patient straight, but that he can be forced to *grow* straight.

In the treatment of dorsal and cervico-dorsal scolioses it is advantageous to use the CHARCOT head-holder. Then the shoulder-crutches must carry none or but very little of the weight of the body, but only serve to fix the shoulder on the inclined plane.

K 4.

Straightening lumbar curvatures (sitting).

The apparatus consists of a chair with a high back and seat which can be adjusted at an angle of 10° — 20° . According to the character of the curvature the patient must sit more or less near to the back of the chair, which can be regulated by a cross-board attached to the seat. The back-support has, about the height of the shoulder, an adjustable cushioned board, the *side-support*, as well as several cross-bars at different heights above and below the same.

The apparatus is in the first place intended to straighten lumbar and total curvatures, so that these are if possible bent in the opposite direction, and with the spine thus straightened or bent, the patient remains in the sitting posture for a certain length of time. The apparatus is used either immediately before or after a group of active movements.

If the patient has, for instance, a left lumbar or total curvature, he seats himself with his right side to the back-support, after the seat has been adjusted at an angle of 20° . The *side-support* is placed so that it presses against the right side of the patient, immediately below the armpit. The right arm is passed above and behind the side-support and the hand grasps one of the lower cross-bars. The physician or medical assistant now tries, assisted by the effect of the inclined seat, to straighten the curvature as much as possible by pressing his left hand against its convexity, or, if the curvature is sufficiently yielding, to bend it over in the opposite direction. Then it can be seen whether the cross-board is to be moved nearer to or away from the back of the chair and whether the seat should be more or less inclined. After the curvature

has been thus, as far as possible, straightened, the patient is left sitting in this position 5—10 minutes.

In cases of double right-sided dorsal with left-sided lumbar curvature the treatment is the same, except that in such cases the patient must sit nearer the back of the chair than in single curvatures, so that the side-support presses more vigorously against the dorsal curvature, and this pressure is still more intensified by the patient's grasping, with his left hand above his head, one of the upper cross-bars, and sometimes pressing himself against the side-support.

It is advantageous to use this apparatus several times a day.

In the treatment of dorsal curvatures which have a direction opposite to the one indicated above, the patient places himself with his left side to the back of the chair.

K 5.

Lateral pressure (sitting).

The object of this apparatus is to lessen, entirely remove or transfer to the opposite side, the unilateral pressure on the dorsal vertebræ, by pressure on the convexity of the dorsal curvature, while the patient at the same time makes some arm-movements which cause unilateral or bilateral contraction of the dorsal muscles.

The pressure is thus brought about that, by means of their angular levers, the two straps for pressure are pressed against the sides of the patient sitting between them. The arms of the levers, which are provided with handles, are suitably pressed down and then fixed by iron-bolts inserted above the levers. The straps can, by means of the gradations, be adjusted partly at different heights from the seat, partly at

different distances from the middle line of the apparatus.

To be able to calculate at what height *the straps* should be fixed, the »*sitting-height-scale*» on the right side of the measuring diagram must be referred to (see the trunk-measuring apparatus). The height-scale of the apparatus K 5 indicates in centimeters the distance, from the seat to the middle of the pressure-straps.

If, for instance, a scoliosis dorsalis dextra — lumbalis sinistra is to be treated, and the greatest deviation of the curvatures is at the height of 45 and 30 cm. above the seat, this is indicated on the prescription in the following manner:

K 5, hr 45, hl 30; A 2 No. 3, L outward, and signifies: *K 5*, height to the right 45, height to the left 30; *A 2, No. 3*; the left arm is raised upward in the frontal plane, that is, not in the usual direction forward, upward and outward. This strengthens the elevators of the sunken left shoulder and forces the muscles of the right dorsal region to a more powerful contraction and straightening of the dorsal curvature. If the head leans to the right, the patient should place his right arm on his head, grasping its left side with his fingers, which has the effect of drawing the head to the right, while the cervical muscles of the left side contract in order to counteract this movement. This is indicated on the prescription by *r. a. o. h.* = right arm over the head. If the dorsal curvature is considerable and stiff and the patient bends the cervico-dorsal part of the spinal column much to the left, the instructor standing behind the patient, should lay his left hand on the patient's left shoulder and press the inferior part of the cervical spine to the right, causing a more vigorous straightening of the dorsal curvature. This is indicated on the prescription by: *l. o. sh. pr.* = to the left over-shoulder-pressure. Should the dorsal curvature be slight with the shoulders almost equal,

but the patient hump-backed (dorsalkyphos). A 2 is executed in the usual way with both arms (forward, upward, backward, outward, downward) by which the dorsal extensors are exercised without any injurious effect whatever on the spinal curvatures. This treatment is applied especially in lumbar curvatures, when the dorsal portion is kyphotic. For flat backs on the contrary this movement should be avoided.

If there is only a single curvature, for instance a left-sided total or lumbar curvature, the left strap is adjusted at an equal height with the greatest deviation, and the right one as high as possible under the right arm where it is to act only as a support against the pressure exercised by the left strap. It is expressed thus on the prescription:

K 5, hr 42 (support), hl 30 (pressure); A 2. No. 3, R. outward. Here, as a rule, the right shoulder is the lower one. The right-sided arm-raising causes a contraction of the left-sided dorsal muscles and counteracts the curvature in the same time as it strengthens the muscles which elevate the right shoulder.

The pressure-straps can generally, always according to the breadth of the patient's chest, be adjusted at a distance of 12—15 centimeters from the middle line of the apparatus. The arm-movement is repeated 10—15 times before the levers are loosened and the patient is set free.

L. Active redressments.

These apparatus exercise a corrective influence on abnormal curvatures of the spine, partly actively, by exercising such muscles as influence the carriage and curvature of the spine, partly by mechanisms, passively correcting abnormal curvatures.

L 1.

Combination of A 3 and D 1.

The apparatus is so constructed that by means of it the movement A 1 can be taken sitting; but while in A. 3 the resistance is brought about by means of iron-weights, the patient here lifts a greater or a smaller portion of his own weight. The seat is carried by a lever upon which the pulley-ropes work. The further the seat is moved away from the rotation-axle of the lever, the more the weight of the body weighs on the pulley-ropes. If both arms pull at both the handles at the same time the work is twice as great as when only one arm pulls while the other is kept extended. In the latter case the stretched side does no work; it is only passively extended by the same force (a fraction of the weight of the body), which the active arm has to overcome. Likewise the work is only half as great, as in the first case, when both arms pull at one handle. For this purpose a bar may be

pushed through the bored brass socket of one of the handles, and both hands grasp this bar. In the last two mentioned methods of application the inclination of the seat is only half as great as when both arms pull at both handles at the same time. For when the lever is raised by pulling at the ropes the seat assumes a slanting position, corresponding to the right or left-sided »trunk-balancing» (D 1 u unilateral, sitting to the right or left) according as the patient is placed with his right or left side to the post which carries the rotation-axle of the lever.

The position of the seat is determined according to the holes in the lever which are marked with the numbers 35, 40, 45, 50 centimeters from the rotation-axle. The pulleys in which the ropes run are movable; their axles are placed in notches which are marked with the same number as the hole in which the bolt fastening the seat, is inserted.

The length of the pulley-rope is so regulated by a strap with a clasp that the starting position of the lever is horizontal when both arms are extended.

The movement is very effective as well in single lumbar and total scoliosis, as in double curvature of the spine, especially when the upper curve is high (cervico-dorsal).

In right-sided dorsal with left-sided lumbar curvature, the prescription is, for instance, as follows:

r. sitting, l. stretch, r. pull No. 40.

In left-sided total scoliosis:

r. sitting, r. stretch, l. pull No. 40.

In left-sided lumbar scoliosis:

r. sitting, both arms pull, No. 40, &c. In this case, when a moderate inclination of the seat is wanted, the patient should pull at the above mentioned bar, and the pulley in which the corresponding pulley-rope runs, be so placed that the latter is suspended exactly

above the middle of the seat, that is, the pulley with the bar must be put in the notch 30.

If a stronger inclination of the seat is desirable, the patient is made to pull at both handles and on the prescription is written $\frac{40-40}{40}$ when the upper two numbers indicate the place of the pulleys, and the one below, that of the seat. But by this means the weight is doubled.

If the lower arm of the lumbar curvature presents a stronger, or a stiff lateral *infraction* against the pelvis, for instance to the left, one ought not to let the patient sit with his right, but with his left side to the post. Thereby a correction of the infraction is effected.

L 2.

Extension or lateral flexion of the lumbar spine.

The apparatus consists of two cushioned benches, a higher one for the legs and a lower one for the trunk. At one end of the higher bench there is an adjustable mechanism for fixing the legs during the movement, — the *foot-catch*, which can be moved forward or backward according to the length of the patient's legs.

The movements which can be accomplished with this apparatus are:

Trunk-holding, lying, face downward. The patient places himself, face downward, on the bench, so that his legs rest on the higher and his trunk on the lower plane, and his position is so adjusted that the upper edges of the iliac bones are on a level with the front edge of the higher plane. The foot-catch is moved forward so far that the patient can place his legs, close above the ankles, in the side-curves of the foot-catch.

The patient now contracts the dorsal muscles, raises the trunk so far that it is on a level with the upper plane and keeps it so for a few moments; *inspiration* commences on raising the trunk, and during expiration the trunk is slowly lowered to the starting position.

Trunk-raising, lying. The arrangement is as before. The patient bends his back upward in a curve, keeps it so for a moment and lets it slowly sink back to the starting position. Respiration as before.

Muscles active: see C 5.

Trunk-raising, half lateral position. The position of the patient is not altogether face downward, but more on one side, that is on the one which corresponds to the concavity of the lumbar curvature. The lumbar muscles are thus more called into action.

Trunk-holding, lateral position. The patient lies down on the side prescribed with the upper edge of the iliac bone against the front edge of the upper plane. The lower leg is placed in the back side-curve, and the free leg in the front side-curve of the foot-catch. The patient now raises his trunk from the lower plane, holds it for a few moments on a level with the legs, and then slowly sinks back into the starting position. Respiration as before.

Lateral flexion in lateral position. The arrangement is the same as before. The patient bends the trunk in a curve upward, keeps it so for a moment, and then lets it slowly sink back into the starting position. Respiration as before.

Muscles active: see C 6.

All the above movements are applied in the treatment of lumbar and total curvatures of the spine. They must be preceded by the use of the K-apparatus K 2, K 3 or K 4 in lumbar, and K 1, K 3 in total curvatures.

In tendency to lordosis *trunkholding, lying, face downward* is better than *trunk-raising*; in total curvatures

lateral flexion in lateral position; in lumbar curvature trunk-holding, lateral position, are the best movements.

L 3.

Carrying the pelvis sideways.

In lateral curvature of the spine the patient has often a tendency to displace the *upper* part of the trunk towards the one or the other side. By means of the apparatus L 3 the patient is exercised in moving also the *lower* part of the trunk towards the same side, in order to obtain a vertical carriage.

Therefore the upper part of the trunk is fixed, while the patient exerts himself to move sideways the lower part of the trunk and the wheeled seat on which he is placed.

Even where such a displacement of the upper part of the body does not exist, the apparatus can be used for straightening a lateral curvature. For this purpose a counter-pressure on the convexities of the curvatures must be exercised while the pelvis is carried sideways.

To serve these various purposes, the apparatus possesses two strong back-bars each of which carries two padded side-bars, movable both in a vertical and in a horizontal direction, and by gradations indicating, in the former case the distance between the upper edge of the side-support and the seat; in the latter case the distance of the side-support from the vertical middle plane of the apparatus.

On the upper side-supports there are handles which the patient holds during the movement. The seat which runs on rollers is drawn towards the one or the other side by means of weights, whereby the resistance in the displacement of the pelvis is brought

about. But care should be taken that the weight is always suspended on the passive side *i. e.* on the one towards which the pelvis is not carried. To the apparatus belong 5 weights representing together 15 units. One represents the unit, two weights represent two units each and two five units each. In a single or double curvature with greater or smaller displacement of the upper trunk towards the right, the prescription may, for instance be as follows:

$$L\ 3, \text{ right, No. } 5 \frac{b : 58 \cdot 16}{r : 50 \cdot 14; l : 0}$$

meaning, that the pelvis is to be carried to the *right*, that the scale to the left of the patient is weighted with 5 units of weight, and the upper side-supports on *both* sides adjusted at 58 cm. above the seat, and at a distance of 16 cm. from the middle line of the apparatus, and that the lower side-support on the *right* side is adjusted at 50 cm. above the seat and 14 cm. from the middle line. These figures are calculated by means of the «*sitting-height-scale*» on the measuring diagram. The lower *left* side-support is moved aside and raised so that it may not be of any inconvenience during the movement.

If in a case of scoliosis *dorsalis-dextra-lumbalis sinistra*, the dorsal curvature is great and the left side very much sunk, the following arrangement is suitable; *e. g.*:

$$L\ 3, \text{ right, No. } 5 \frac{r\ 47 \cdot 16 : l\ 52 \cdot 17}{0}$$

The two lower side-supports are not used in this movement, but are moved to one side and raised. By the high fixation of the left shoulder, and by counter-pressure against the convexity of the dorsal curvature, the patient is forced, when the pelvis is carried to the right, to stretch the concave side and straighten the dorsal curvature.

While the movement is being accomplished, the patient grasps both handles and constantly fixes the upper part of trunk by pressure of the upper arms against both the side-supports. The patient is held on the seat by a strap fastened across the legs. To prevent the patient from carrying the pelvis too far over on the other side during the passive phase of the movement when it is moved back towards the middle line, there are under the seat two straps of which the one that, in the example given, is to be found on the active side, is occasionally fastened to a button on the foot-support.

L 4.

Carrying the pelvis forwards-backwards.

The apparatus consists of a frame on which a wheeled seat can be made to run backwards and forwards. When the patient seats himself and takes hold of one of the cross-bars at the front end, he can push himself forward and backward. In order to produce resistance, the front or back end of the frame is placed on a trestle, according as the active phase of the movement shall be the moving backward or forward.

1) *L 4 forwards.* The trestle is placed under the front end of the frame. The movement must be executed with well stretched arms and the back *crooked* (kyphotic).

Acting muscles: *Latissimus dorsi*, *teres major*, *rhomboides*, the middle portion of *cucullaris*, *levator anguli scapulae*; the *abdominal* muscles and *gluteus maximus*. The combination of these muscles counteract the *lordosis*.

2) *L 4 backwards.* The trestle is placed under the back end of the frame. In this movement the initial position of the seat should not be at the lowest

end of the frame but rather higher up, so that the trunk of the patient in the starting position with forward stretched arms, is vertical. By means of a strap with a buckle the seat is adjusted at the suitable height. During the whole movement the patient should take care to *keep the back swayed* (lordotic).

Acting muscles: The anterior third of the *deltoideus* and the *serratus anticus major*, *erector spinæ*, particularly *sacro-lumbalis*, *iliopsoas*. The last two muscles working together produce a *lordosis* and increase the inclination of the pelvis; the formation of lordosis is however counteracted and a pure straightening of the back obtained, if the patient exerts himself to elongate the trunk and push the seat backwards as much as possible. This is effected by the above-named muscles in combination with the *abdominal muscles* and the *glutæi maximi*.

The description of the physiology of this movement may serve as a direction for the use of it, as this must always be carefully individualized and accurately calculated according to the spinal line in profile as indicated in the trunk-measuring diagram.

During the movement the arms can also be bent or stretched, and thus trunk- and arm-movements are combined.

Should there be a lateral curvature of the lumbar spine the patient should be placed on a slanting board with its higher edge turned to the same side as the convexity of the curvature. Three such slanting boards with resp. 6° , 8° , 10° inclination belong to the apparatus and are by a special mechanism fastened to the seat.

On the prescription the movement is thus indicated:

L 4 forwards. (event. *right* or *left high-sitting* 6° (8° , 10°) and with or without *arm-flexion*).

L 4 backwards. (event. *r.* or *l. hs.* 6° (8° , 10°), with or without *arm-extension*.)

L 5.

Lateral flexion of the lumbar spine.

The object of this apparatus is to produce actively the same lateral flexion as is executed half passively by the apparatus D 1 (as D 1 u, used to the right or left). But L 5 offers the advantage that the movement becomes more powerful; this apparatus is quite independent of the motor and has a fixing-mechanism for the upper part of the trunk. The fixing is accomplished by means of side-supports like those of L 3.

After the patient has placed himself on the seat and the side-supports have been applied according to the prescription (see below), a padded strap fastened on the seat is stretched over the convexity of the lumbar region, *i. e.* round the side opposite to the one indicated on the prescription. The cushion should be so placed that it presses most on the back of the lumbar region.

When the patient has taken hold of the handles and pressed the side-supports tightly between the upper arm and the thorax, he should press down that side of the pelvis which is indicated on the prescription, whereby the lumbar region is bent in this direction. If the patient ceases to press the hips down, the seat returns to the horizontal position by means of a spring and a counterbalance. This movement is repeated 10—12 times.

Since the movement acts first and most on the lumbar spine, that side of the pelvis must be lowered which corresponds to the concavity of the curvature, in order to accomplish the desired correction. In *lumbalis sinistra*, *totalis sinistra*, and *dorsalis dextra-lumbalis sinistra* L 5 *right* is prescribed and the strap is stretched round the left side of the waist. The

position of the side-supports is determined according to the height-scale on the trunk-measuring diagram (see L 3); as a rule they are adjusted high in the armpits and at equal heights, when the compensatory dorsal curvature is not strongly developed. In the latter case the side-support is placed higher on the concave side of the curvature. In *dorsalis-dextra — lumbalis-sinistra* the prescription runs, for instance as follows:

$$L \ 5, r \cdot \frac{h \cdot 46}{d \cdot 16} l \cdot \frac{h \cdot 48}{d \cdot 16};$$

this notation indicates the *height* of the side-supports and the *distance* from the middle line to the right and left. If the dorsal curvature is strong, there can be added: *l. o. sh. pr.* (see K 5).

L 6.

Straightening the spine.

The apparatus consists of a seat and of a stand, carrying a lever with a movable weight. By means of a parallelogram of iron bars, there is fastened to the bottom side of the lever a head-cushion, which can be adjusted at different heights above the seat, by the gradation on the vertical iron bars, expressed in centimeters. The patient places himself on the seat and the head-cushion must be so adjusted that when the patient has a crooked (though upright) position, the cushion touches his head. The height indicated on the prescription can as a rule be adjusted about 3—7 cm. lower than the distance from the seat to the crown of the head, indicated on the scale of the trunk-measuring diagram (see p. 123). The movement is so executed, that the patient straightens himself and thereby pushes the weighted lever upward. This is repeated

8—12 times. By the action of the muscles this movement causes the patient to straighten the spine as much as possible and to lengthen the trunk. This acts on all curvatures of the spine in proportion as they are yet naturally flexible, or have been made flexible by the K-apparatus. Not until mobility has been restored can the movement have a more powerful effect, but then it is of very great use by accustoming the patient to an erect carriage.

When the lumbar curvature is great, the patient can be placed on an inclined seat, so that its higher side is under the hip which corresponds to the convexity of the lumbar curvature.

In the prescription the movement is indicated as follows, *e. g.*:

L 6, No. 6; h : 70; l. hs. 8°; which means; the weight is placed at number 6; the height of the head-cushion is 70 cm.; the patient is placed on a seat, inclined at 8°, so that the left side is raised.

If the curvatures are great and yielding, and the patient delicate, the support of the medical attendant may be necessary, for instance in habitual double curvature: *rh, ll, lateral pr.* = right high, left low, lateral pressure.

Measuring apparatus.

Trunk-measuring apparatus.

The apparatus consists 1.) of the round graduated *foot-plate* on which the patient is standing when the measuring takes place, and on which the position of the feet can be exactly determined by means of the foot-adjustment mechanism; 2.) of the *centralising-mechanism*, by means of which the pelvis of the patient is adjusted centrally in the apparatus and fixed; it consists of the two hip-bows, the distance between which is determined by means of a screw running to the right and left, and it can be adjusted at different heights above the foot-plate; 3.) of the *head-holder* with its crown-plate, fore-head plate and its eccentric scales for determining and fixing the position of the head; 4.) of the *height-scales*, two vertical poles graduated in centimeters and millimeters, and placed exactly opposite to each other; these can be turned round the foot-plate. Their position is determined by the gradation on the foot-plate, and their object is to measure the height of a given point above the foot-plate; 5.) of the *eccentric scales*, horizontal, graduated bars, movable along the height-scales; at the inner ends of these bars different pieces can be attached, such as points, one- or two-armed cross-bars, the breast-plate, as well as the so-called »*double-measurer*». These are used for determining the distance of a point from the central line of the apparatus; the double-measurer also shows

the rectangular distance of the point from the vertical plane in which the height-scales are.

When the outlines of the trunk are to be measured in the frontal plane, the patient takes hold of a cross-bar suspended on a string from the ceiling and which can be adjusted at different heights.

Before the measuring the line of the spinal column, from the seventh cervical vertebræ down to the *rima natium*, is drawn with a brush and Indian ink; the acromial angle (the angle between the *acromion* and the *spina scapulæ*) and the lower angles of the shoulder-blades are marked, as well as other points of which it is desirable to determine the position.

The measuring is accomplished in the following manner: The patient places himself on the foot-plate so that the *trochanter major* is opposite to the deepest curve in the hip-bows; the latter are adjusted on a level with the trochanter major and screwed tight, by which means the pelvis is fixed. Then the *head-holder* is let down so far that the crown-plate touches the crown of the head, and the eccentric scales (of the head-holder) are pushed to the sides of the head and fixed, when moving the head from its natural position towards the middle axis must be avoided, as it would be wrong artificially to change the pathological carriage of the patient, which is exactly what the measuring is intended to illustrate. After that one can read off the whole length of the body and the deviation of the head to the right or the left. Then, the position of the acromial angle, and, after the arms have been raised, the outline of the trunk in the frontal plane are determined (by means of the ordinary eccentric scales), points in these outlines being measured at every 5th—10th centimeter. Then the height-scales are turned to the sagittal plane of the body, the breast-plate placed below the breast-bone of the patient and the curvatures of the spinal line measured

as well in the frontal as the sagittal plane, by means of the *double-measurer*, the situation of a number of points being determined, chiefly those that show the greatest deviations and those where the spinal line crosses the middle line.

All the measures obtained in this way are noted by a registrar, who afterwards marks the measured points on paper ruled in small squares and joins them by lines. Thus two trunk-measuring diagrams are obtained, one in the frontal and one in the sagittal plane.

On the left side of the diagram is a scale indicating the height in the standing position at every fifth or tenth centimeter. This scale is used when making the prescription for the apparatus K 1, K 2 and K 3. But for the apparatus K 4, K 5, L 1, L 3, L 5, L 6 a height-scale in the sitting position is wanted. Therefore, before finishing the measuring the patient should be made to sit on a chair beside the measuring apparatus, and the height of the 7th cervical vertebræ (before marked when measuring the spinal line) be ascertained by means of one of the *eccentric scales*, which for this purpose is reversed. The distance between the edge of the eccentric scale and the chair is the sitting-height, which should be noted and a corresponding scale marked off on the right side of the diagram (*sitting height scale*).

The apparatus is in the first place intended to ascertain the carriage and the shape of the body for the treatment of scoliosis, but it is evident that it can also be employed for measuring the position and degree of other deformities or deviations from the normal and symmetrical development.

On application, apparatus with three height-scales are supplied, on which one can read off at the same time the measuring-points in the transverse vertical section and the deviations of the spinal line. The ap-

paratus so constructed are naturally a little more expensive, while at the same time it is uncertain whether a more convenient measurement can be effected with it.

Cross-cut-measuring apparatus.

With this apparatus which is constructed after the same design as a hatmakers mechanical head-measure it is easy to obtain transverse (cross-cut) sectional diagrams of the trunk. Its mechanism consists of 32 movable small steel-bars which are arranged like radii round 4 different centres, so that their inward points furnished with wooden buttons when they are equally drawn back, form an oval ring which approximately corresponds with the transverse section of the thorax. By means of small lead-weights these measuring-bars are pushed forward towards their respective centres and with their wooden-buttons touch the body which is in the central opening of the apparatus; they give the exact outline of the transverse sectional plane of the thorax at the desired height. At a distance of 12.5 centimeters from the wooden buttons there is on each bar, a small steel-point which is turned upwards. If papers are placed between the iron-plates of the apparatus and pressed against the steel-points we obtain on the papers a larger copy of the ring formed by the wooden-buttons. The papers are taken out, placed on a paste-board, on which the direction-lines of the measuring-bars are marked and the holes of the steel-points are projected on another piece of paper (best on a transparent parchment paper so that the direction-lines shine through). When the points thus projected are united by lines, a diagram is obtained which gives the transverse sectional outline in natural size. The measuring-board is divided into two halves which are drawn apart while the patient places him-

self in the central opening. The measuring-bars are then drawn back by means of a particular mechanism and released again as soon as the patient has taken his place and the measuring-board is closed.

The patient is made to breathe deeply, the paper is quickly pressed against the steel-points and the measuring is completed. If the holes already made by the steel-points are marked with a pencil, several outlines at different heights and under different circumstances can be taken successively.

The cross-cut measuring apparatus is useful, not only in the treatment of scoliosis when it is desirable to ascertain the kind and degree of the distortion of the thorax, but also in other cases where it may be of interest to note the development or symmetry of the thorax, as in diseases of the lungs and heart.

Examining-chair

(in the treatment of scoliosis).

In the treatment of scoliosis after my method where the use of the fixed or movable inclined seat often occurs, it is of great importance to be able to examine easily and reliably what influence is exercised on the carriage of the spinal column by the inclined seat at various angles. For this purpose I have constructed an apparatus which I call an «examining-chair» and by means of which the above mentioned examination can easily be accomplished. By a centralising-mechanism the patient's position in the middle of the seat can be secured, and by another screw the inclination of the seat can be adjusted up to 20° on each side.

All these apparatus are manufactured exclusively and under my control at the mechanical works of Göransson's Mekaniska Verkstad Company Limited in Stockholm.

To those physicians who desire to establish Medico-mechanical gymnastic Institutes, all necessary information will be readily supplied by the above mentioned Company.





